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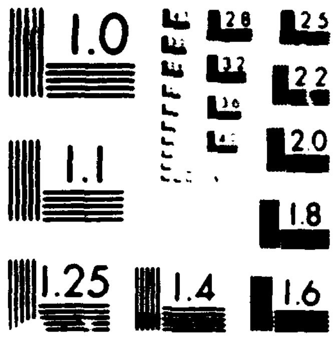
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The Strategic High-Altitude Atmospheric Radiation Code (SHARC) User Instructions

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This report describes how to implement and use the Strategic High-Altitude Radiance Code (SHARC). SHARC calculates atmospheric radiation for paths from 60 to 300 km altitude in the 2-40 μm spectral region. It models radiation due to NLTE (Non-Local Thermodynamic Equilibrium) molecular emissions which are the dominant sources at these altitudes. This initial version of SHARC includes the five strongest IR radiators, CO_2, NO, O_3, H_2O, and CO. The code is available on magnetic tape and can be obtained by written request to AFGL/OPB. Carbon Dioxide, Carbon Monoxide, Vapor, Nitrogen Monoxide, Ozone,

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1. INTRODUCTION

This user's manual for the Strategic High-altitude Atmospheric Radiation Code (SHARC) presents both an overview of the modeling approach as well as detailed code implementation and running instructions. SHARC predicts infrared (IR) atmospheric radiation and transmittance in the 2-40 μm spectral region at a spectral resolution of 0.5 cm^{-1} and includes the important bands of NO, CO, H_2O, O_3, and CO_2. It allows for arbitrary paths within the 60 to 300 km altitude region, such as limb, horizontal, vertical, slant, point-to-point, and space-viewing geometries. A full technical discussion of the modeling approach will be provided.

Generally above an altitude of 60 km collisional excitation and de-excitation processes between molecules occur on a time scale comparable to radiative decay. This leads to a condition of Non-Local Thermodynamic Equilibrium (NLTE) where the various degrees of vibrational, rotational, and translational freedom cannot be characterized by a single temperature. In this regime the concept of temperature, which implies a Boltzman distribution of excited-state populations, is invalid, and the explicit molecular excited-state populations need to be determined. In order to compute these populations, a comprehensive model is required which incorporates all the important physical processes which for this problem include: (1) collisional excitation, de-excitation, and energy transfer; (2) chemical production of excited-state molecules; (3) radiative decay; (4) external source excitation due to solar and earthshine pumping; and (5) internal radiative excitation due to emission and absorption by molecules within the atmosphere. All these effects are incorporated in SHARC.

SHARC is a completely new code which emphasizes modular construction so that models and model parameters can be easily modified or upgraded as additional data and/or better models become available. The present modules include input, chemistry, radiative transport, geometry, and output. The input module is interactive and menu-driven. It reads in the model atmosphere and prepares inputs for the rest of the code. The next step is calculation of the excited-state populations. This is accomplished in the chemistry module which iterates between a generalized chemical kinetics module that calculates

excited-state populations due to solar and earthshine excitation and a Monte-Carlo based radiative transfer model that calculates radiative excitation and energy transfer between atmospheric layers. The geometry module determines the species column densities for each layer traversed by the user's requested path. The radiative transport module then calculates the radiance along the path for each molecular excited state. The calculation is done on a line-by-line basis in that the total radiation from each line is calculated using a single-line equivalent-width formulation that incorporates a Doppler-Lorentz (Voigt) lineshape.[(1)] Finally the results are passed to a separate plotting package which prepares a spectral plot of the calculated radiance.

Additional upgrades to SHARC are planned. These include an auroral model which is based on AARC (Auroral Atmospheric Radiation Code),[(2)] inclusion of isotopes of primary molecules, especially $^{13}CO_2$, additional radiators, such as OH and O_2 bands, extension down to 50 km altitude, and a model for lines of sight that cross the day-night terminator.

2. PROGRAM OVERVIEW

There are three major components of the overall SHARC software package, and these are indicated in Figure 1. The INTERPRETER, which is a modified version of that furnished with the Sandia CHEMKIN code,[3] prepares the differential equations for the chemical/kinetic reaction scheme. This module is run only when changes are made to the reaction scheme or its associated rate constants. The SHARC chemistry/radiation module is composed of many sub-modules, each of which models a specific physical process. This module utilizes the differential equations set up by the INTERPRETER and associated atmospheric and spectroscopic data to determine spectral radiances for arbitrary spectral regions, molecular emitters, and viewing geometries. Finally, a PLOTTING package is provided which allows the user considerable flexibility to vary the display format of the spectral radiance plots. The functions of each of these modules are described in the following sections.

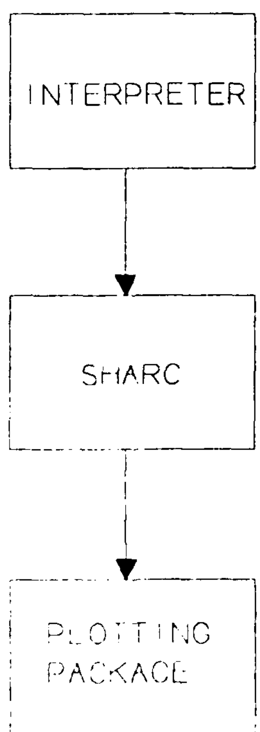

Figure 1. Major Components of SHARC.

2.1 The INTERPRETER Program

The SHARC CHEMKIN module computes the steady-state number densities of vibrationally excited atmospheric species from a set of chemical kinetics/reaction mechanisms. The chemical kinetics mechanism describes molecular formation, all forms of vibrational energy transfer, and the absorption of solar and/or earthshine radiation. SHARC's access to the chemical kinetics mechanism and associated input (i.e., energy transfer or reaction rate constants) is provided by a program called the INTERPRETER. The INTERPRETER reads a symbolic description of an arbitrary chemical kinetics mechanism (written in a manner just as a chemical kineticist would write it), and creates a binary "linking" file which contains all of the kinetics information. The SHARC INTERPRETER is based entirely on and includes subroutines directly from the Sandia Livermore INTERPRETER code which is provided with the CHEMKIN code.[3] The Sandia CHEMKIN package is described as "a general-purpose, problem-independent, transportable, FORTRAN chemical kinetics code."[3] The SHARC INTERPRETER is a modified Sandia interpreter from which information on elements in the periodic table, the thermodynamic data base (useful for combustion reactions), and reversible reactions, extraneous for our application, has been removed.

Once the chemical kinetics mechanism has been formulated, the INTERPRETER provides the vehicle by which the information is transferred to the CHEMKIN module in SHARC. The INTERPRETER reads a symbolic description of an arbitrary chemical kinetics mechanism in a manner that is just as would be written by a chemical kineticist; it then translates this information into the appropriate differential rate equations. To be more specific, consider I irreversible kinetic (energy transfer or reactive) processes, each given in the general form

$$\sum_{k=1}^{K} \nu_{ki} C_k \xrightarrow{k_i} \sum_{k=1}^{K} \nu'_{ki} C_k \quad , \tag{1}$$

where the stoichiometric coefficients ν_{ki} are integers; the C_k is the chemical symbol for the k^{th} species; and k_i is the rate constant for the ith process. The INTERPRETER reads this symbolic description of an arbitrary chemical

kinetics mechanism and provides the data necessary to translate the mechanism into the appropriate differential equations

$$\frac{dw}{dt} = \sum_{i=1}^{I} (\nu'_{ki} - \nu_{ki}) k_i \prod_{k=1}^{K} [C_k]^{\nu_{ki}} \quad . \tag{2}$$

All the variables defined in Equations (1) and (2) are written into a binary "linking" file. The INTERPRETER only has to be run once for a given kinetics mechanism and data base. The "linking" file is then saved and used by SHARC for all subsequent calculations. Of course, if the kinetics mechanism or data base is changed, the INTERPRETER has to be rerun.

2.2 SHARC

The schematic shown in Figure 2 illustrates the calculational sequence for SHARC. Except for the PLOTTING and the INTERPRETER modules, which are run separately, all the modules are called by the MAIN program.

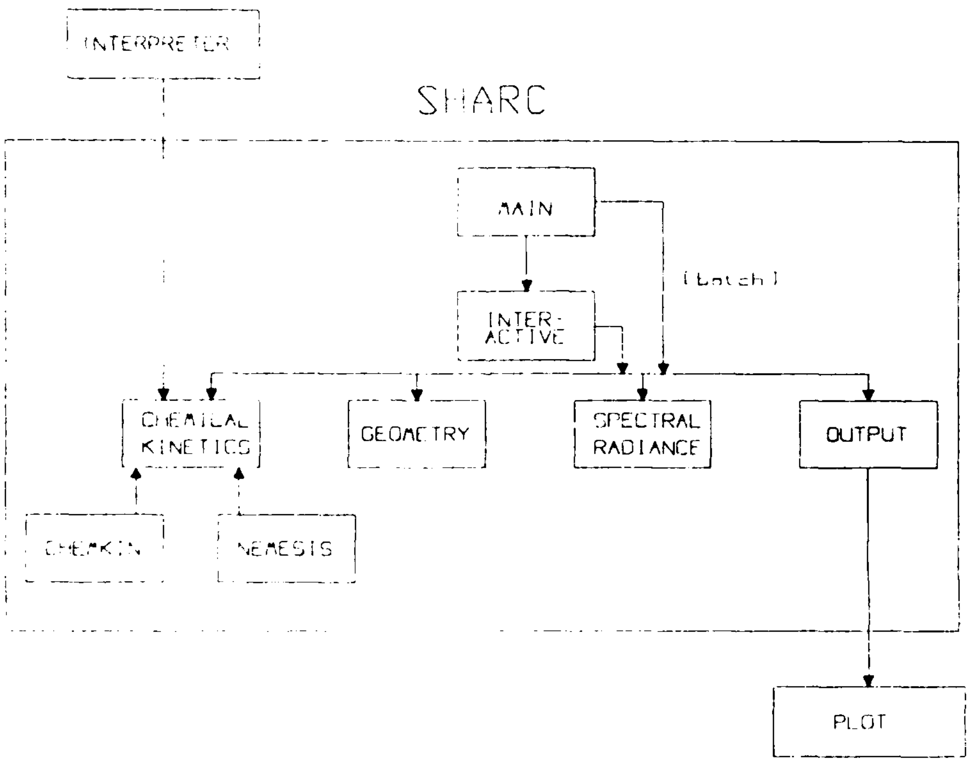

Figure 2. Calculational Sequence for SHARC.

The interactive input module queries the user for the parameters needed by the rest of the code. The MAIN program reads in the appropriate atmospheric profile and determines the temperature, pressure, and species concentration for each layer.

The atmospheric chemistry modules, CHEMKIN and NEMESIS, calculate the NLTE populations for the various molecular excited and ground states. CHEMKIN calculates excitation due to chemical reactions plus solar and earthshine pumping. NEMESIS then calculates changes in the excited-state populations due to radiative transfer between molecules within the atmosphere.

The GEOMETRY module determines the line-of-sight (LOS) trajectory parameters for the viewing geometry requested by the user. It uses the density profiles calculated by CHEMKIN-NEMESIS to determine the LOS column densities for each excited state. Arbitrary paths between 60 and 300 km are allowed, including limb viewing from space, vertical and horizontal paths, and slant paths of arbitrary length and direction.

The SPCRAD module utilizes the geometry information provided by GEOMETRY and the state populations provided by CHEMKIN-NEMESIS along with a molecular spectroscopic data base to determine the LOS spectral radiance.

2.2.1 The INPUT Module

The INPUT module is used to interactively change input parameters required for a SHARC calculation. This module is used only when SHARC is run interactively. When SHARC is used in the batch or background mode, a previously created input file must be used. In the interactive execution mode, SHARC will look for the input file called "SHARC.INP". This file contains the user-supplied input parameters for SHARC (several of these files are supplied on the SHARC computer tape and discussed in the test case section of this manual). If "SHARC.INP" is not found, the input module will use a set of default values for all input parameters. Once SHARC has a set of input parameters, the input module displays the top-level input menu. The query-style menus used in the input module were modeled after the input menus used in the AFGL Auroral Atmospheric Radiance Code (AARC).(2) The top-level menu looks like this:

REVIEW OR MODIFY INPUT PARAMETERS

1. TITLE FOR CALCULATION*
2. MODEL ATMOSPHERE
3. NEMESIS CONTROL PARAMETERS
4. MOLECULAR EMITTERS*
5. SOLAR ZENITH ANGLE
6. POPULATION FILE*
7. LOS GEOMETRY*
8. SPECTRAL INTERVAL AND RESOLUTION*
9. OUTPUT DATA*

* OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
11. EXIT WITH NO UPDATE OF DEFAULT FILE

ENTER # OF ITEM TO BE CHANGED
0 TO CONTINUE SHARC EXECUTION

The user can enter a number from 1 to 9 to enter a submenu on topics 1 through 9. The submenu will start by reviewing the current parameter values found in SHARC.INP, and the user can then select a parameter to be changed. The value is then changed simply by typing in the new value and then entering a 0 will return the user to the submenu level. Entering another 0 will return the user to the main menu. At this stage the user can enter another submenu by inputing a value from 1 to 9 or, by entering a value of 10, the user can exit the input menu and update the "SHARC.INP" file for a batch calculation. Entering an 11 will exit the SHARC calculation without changing the "SHARC.INP" file (used to quit SHARC when many input parameters have been incorrectly entered), and entering a 0 will allow SHARC to continue interactive execution. A more complete example of an interactive input session is described in Section 4.2.

Changes made to input parameters will be saved in the "SHARC.INP" file. The first parameter in "SHARC.INP" determines whether SHARC is to be run in an interactive or batch/background mode. When this parameter is a 1, SHARC will run interactively and enter into the input module. When this parameter is 0, SHARC will execute in a batch or background mode and skip the input module. This parameter is set to a value 1 after complete execution of SHARC so that

the default mode for SHARC is the interactive mode. If a batch run is desired, this parameter can be changed by editing the "SHARC.INP" file, or one can exit SHARC with option 10 which prepares "SHARC.INP" for batch execution, i.e., the mode parameter is set to 0.

2.2.2 The CHEMKIN Module

The CHEMKIN module computes the steady-state number densities of vibrationally excited atmospheric species from a set of chemical kinetics/reaction mechanisms for each atmospheric layer Again the subroutines comprising the CHEMKIN module are based on those included in the Sandia Livermore CHEMKIN package.[3]

The CHEMKIN module uses the input read from the "linking" file (species identification, stoichiometric coefficients, and rate constant parameters) to construct the steady state equations for the vibrationally excited states

$$\sum_{i=1}^{I} (\nu'_{ki} - \nu_{ki}) k_i \prod_{k=1}^{K} [C_k]^{\nu_{ki}} = 0 \qquad . \tag{3}$$

The variable definitions are identical to those defined in Equation (2). In general, solving Equation (3) for the vibrationally excited-state densities requires a nonlinear equation algorithm. However, using the assumption that the ν_{ki} of the vibrationally excited species (i.e., the unknowns in the problem) are unity, Equation (3) simply reduces to a set of linearly independent algebraic equations for the N unknown excited-state number densities. This assumption is not overly restrictive and has been used previously.[4] The information necessary to solve Equation (3) is simply the atmospheric species number densities and the kinetic temperature from which the rate constants are computed. SHARC then uses a lower/upper (LU) decomposition algorithm to solve Equation (3) for the number densities.

2.2.3 The NEMESIS Module

The NEMESIS (Non-Equilibrium Molecular Emission and Scattering Intensity Subroutine) module computes the enhancement of the atmospheric excited-state layer populations due to layer radiative self-trapping and layer-layer

radiative pumping. Some molecular bands, in particular the 4.3μm CO_2 band, are optically opaque to emitted radiation. Photons emitted in these bands may be absorbed and emitted many times before either escaping the atmosphere or becoming collisionally quenched.

The overall approach for determining the enhanced excited-state level populations involves:

- determination of the steady-state layer source populations which includes excitation by external light sources, sun and earthshine, and molecular collisions, and de-excitation by radiative decay and collisional quenching;

- determination of the first-order population enhancement using a Monte Carlo simulation of the initial source photon emissions and their subsequent absorption or escape; and

- determination of the total enhanced populations using a recursive orders-of-enhancement approximation which is initialized by the Monte Carlo first-order results.

The source populations include all sources of excitation exclusive of the internal atmospheric radiative effects of layer self-trapping and layer-layer pumping. CHEMKIN is used to generate the source populations that are then input into NEMESIS. The key results from the Monte Carlo simulation are the first-order enhancements and the probabilities that a photon emitted from a layer "i" will create a new excited-state in a layer "j". This simulation involves sampling over the initial emission position, emission direction, emission frequency, emission line strength, and length of travel. The contribution of each succeeding order-of-enhancement is determined recursively by

$$(P_k) = (P_{k-1})(W) \quad , \tag{4}$$

where (P_k) is the kth-order layer population enhancement matrix, and (W) is the layer-layer absorption probability matrix. Both (P_1) and (W) are determined by the first-order Monte Carlo calculation.

The end result of each NEMESIS calculation is the total excited-state population distribution for a pair of vibrational levels, where the lower level of each pair may itself be an excited level. A cycling procedure

between CHEMKIN and NEMESIS is used to step up the vibrational energy ladder until the top of the ladder is reached. Finally, the NEMESIS populations are passed to the SPCRAD module for line-of-sight spectral radiance computation.

2.2.4 The Geometry Module

The GEOMETRY module in SHARC calculates a set of parameters which characterizes the line-of-sight (LOS) trajectory. There are three general categories of LOS's which are supported by SHARC:

- observer to a specified source location,
- observer to space, and
- limb viewing (space to space).

In addition to defining the LOS, the GEOMETRY module also calculates the column densities for ambient and vibrationally excited atmospheric species.

GEOMETRY is designed to give the user considerable flexibility in defining the LOS. It computes a uniform set of path quantities from one of many possible subsets of parameters specified by the user. For example, consider the parameters necessary to define the LOS for a path from an observer at Point A to a source at Point B. The LOS between these points can be specified by defining the altitude, longitude, and latitude for Point A, and either the altitude, longitude, and latitude for Point B, or the range between A and B and the zenith and azimuthal angles defined by the LOS direction. The full range of geometry inputs are discussed in Section 7.

2.2.5 The SPCRAD Module

SPCRAD computes the LOS spectral radiance using a finite-difference form of the radiative transfer equation. The LOS properties are specified in homogeneous segments where each segment corresponds to the LOS path through a particular atmospheric layer. A single-line equivalent width approximation based on the Voigt lineshape is used to determine the segment transmittances and radiances. This approach enables the spectral radiance to be calculated at a spectral resolution as high as 0.1 cm^{-1}, although the resolution in the current version of SHARC is set at 0.5 cm^{-1}. Since the radiation computation

is explicitly based on the difference of the upper and lower state populations, it is equally valid in both the NLTE and LTE regimes. Line strengths and locations are taken from a modified line file generated from the AFGL HITRAN line atlas[5] and augmented with additional lines from various hot bands (currently the O_3 hot bands around 10 μm).[6] The major modification to the line parameter data base was to decompose the energy of the lower state into vibrational and rotational energies. This enables the line strengths to be scaled separately for the rotational temperature and the NLTE vibrational population of the lower level.

There is a trade-off between speed and accuracy when the atmosphere is layered into many homogeneous layers. The LOS radiance calculation depends linearly on the number of layers. Currently the atmospheres used by SHARC are layered by 2 km from 60 to 150 km and by 10 km steps from 150 to 300 km. For a limb calculation at a tangent height of 60 km up to 119 atmospheric layers are traversed by the LOS. In order to reduce the computational burden for such cases a user-selectable relayering option is available. When selected, this option is automatically applied to optically thin transitions where it is the total column density of excited states and not the individual segment column densities that drives the radiance prediction. In this case, the atmosphere is relayered by combining a number of adjacent layers into a single larger layer where the total column density is preserved and other properties, such as rotational and translational temperature, are appropriately averaged over the combined layers. Up to an order of magnitude increase in speed, with very little loss in accuracy, can be attained with this approximation.

2.2.6 The OUTPUT Module

The OUTPUT module writes data and error statements to four separate data files. The files are the error file which is called "SHARC.ERR", the general output file, "SHARC.OUT", the spectral radiance file "SHARC.SPC", and the 'population' file, which is named by the user.

"SHARC.ERR" will contain error and warning statements generated by a SHARC calculation. An error message is generated by a fatal problem in SHARC, and execution will stop after the error message is placed in the error file. A warning is not fatal to SHARC, but it may alert the user that only a partial

calculation has been performed or that numerical difficulties have been encountered and fixed in some module of the code. The user should get in the habit of looking at the error file after every SHARC execution to insure that the full desired calculation was actually performed.

"SHARC.OUT" contains a summary of the output from each module. There are three levels of output which can be obtained from each SHARC module. The level of output is selected through the interactive menu and can be defined independently for several of the SHARC subroutines or modules. The first level contains a minimum amount of information. For example, the minimum amount of information on the model atmosphere would be simply the model atmosphere name. The next level of output provides more detailed information such as the number densities of the atmospheric species as a function of altitude, or the vibrational temperatures from the chemical kinetics module. Finally, the highest level of output provides intermediate results from within modules. This level of information may be necessary for "debugging" a problem encountered in SHARC, but is usually too detailed for day-to-day execution.

"SHARC.SPC" is the spectral radiance file and contains the spectral radiance in $W/sr/cm^2/cm^{-1}$ as a function of frequency in cm^{-1}. The resolution and frequency range is defined through the "SHARC.INP" file and/or the input module. Currently SHARC does not have a filter function routine. The data must be degraded by the application of a filter function <u>after</u> the SHARC calculation has been performed.

The population file saves the excited state populations and other necessary information so multiple SHARC calculations can be performed without re-calculating the populations each time. The population for each layer in the model atmosphere will change only when either a new model atmosphere is used, day and night conditions change, or a new solar zenith angle is defined. By saving the populations, a user can build up a library of population files for the model atmospheres of interest. Since the calculation of the NLTE populations requires roughly half of the calculation time required for a full SHARC run, considerable computational time can be saved by using population files.

2.3 Plotting Package

The plotting software is a separate package which can be used to plot the spectral output of a SHARC computation. The plotting program is a general x-y plotting package. It is interactive and has two menus of options. The plotting package reads an input file which is a format-free list of x,y pairs without any header information. After the input file is read, plotting options can be changed through interactive menus. Default options are provided for convenience when plotting a SHARC output spectrum. The software can also be used for other plotting tasks. The plot and axis titles can contain superscripts, subscripts, as well as Greek and special characters. The program is written in Fortran 77. The program is designed to be as device independent as possible. It requires only standard Calcomp calls to initialize and terminated plotting, and a standard Calcomp call to move the pen.

3. SHARC INPUT FILES

3.1 INTERPRETER Files

The INTERPRETER reads the symbolic description of a chemical kinetics mechanism from an ASCII input file and writes the information describing the mechanism to a binary output file (the "linking" file) for subsequent use by the CHEMKIN module in SHARC. The input required by the INTERPRETER is the species name used in the mechanism and the mechanism itself. An example of the CO chemical kinetics mechanism input file currently used by SHARC is given in Table 1.

The information contained in the input file is given in an 80-column card format. All input to the INTERPRETER is format free. The INTERPRETER checks each input card for proper syntax and writes self-explanatory diagnostic messages to the output file if bad syntax is encountered. If any errors are encountered, the INTERPRETER does not create the linking file. Therefore, the input must be error free before SHARC can be executed.

The rules for creating the INTERPRETER input file have been described in detail in Reference (4). Subsections 3.1.1 and 3.1.2 have reproduced this input procedure as previously described. Some changes to the information expected in the SHARC INTERPRETER input file are incorporated in these sections.

TABLE 1. CURRENT SHARC INTERPRETER REACTION MECHANISM INPUT FILE.

```
CO SHARC CHEMICAL KINETICS MECHANISM
SPECIES
N2  O2  O  CH4  CO2  H2O  NO  N2O  O3  CO
N2(0) N2(1) O2(0) O2(1)
CO(0) CO(1) CO(2)
END
REACTIONS
M + CO(1)  -  M + CO(0)                  6.67E-08   0.0   208.3     0.0
      N2/1.0/  O2/1.0/
M + CO(0)  -  M + CO(1)                  6.67E-08   0.0   208.3  3083.7
      N2/1.0/  O2/1.0/
M + CO(2)  -  M + CO(1)                  1.33E-07   0.0   208.3     0.0
      N2/1.0/  O2/1.0/
M + CO(1)  -  M + CO(2)                  1.33E-07   0.0   208.3  3045.6
      N2/1.0/  O2/1.0/
M + CO(2)  -  M + CO(0)                  1.33E-07   0.0   208.3     0.0
      N2/1.0/  O2/1.0/
M + CO(0)  -  M + CO(2)                  1.33E-07   0.0   208.3  6129.3
      N2/1.0/  O2/1.0/
O + CO(1)  -  O + CO(0)                  9.90E-08   0.0   118.1     0.0
O + CO(0)  -  O + CO(1)                  9.90E-08   0.0   118.1  3083.7
O + CO(2)  -  O + CO(1)                  1.98E-07   0.0   118.1     0.0
O + CO(1)  -  O + CO(2)                  1.98E-07   0.0   118.1  3045.6
O + CO(2)  -  O + CO(0)                  1.98E-07   0.0   118.1     0.0
O + CO(0)  -  O + CO(2)                  1.98E-07   0.0   118.1  6129.3
CO(0) + N2(1)  -  CO(1) + N2(0)          6.98E-13   0.0    25.6     0.0
CO(1) + N2(0)  -  CO(0) + N2(1)          6.98E-13   0.0    25.6   268.5
CO(0) + O2(1)  -  CO(1) + O2(0)          3.50E-10   0.0   124.0   844.4
CO(1) + O2(0)  -  CO(0) + O2(1)          3.50E-10   0.0   124.0     0.0
CO(1)  -  CO(0) + HV                      30.96     0.0     0.0     0.0
CO(2)  -  CO(1) + HV                      60.45     0.0     0.0     0.0
CO(2)  -  CO(0) + HV                       1.03     0.0     0.0     0.0
CO(0) + HV  -  CO(1)                        0.0     0.0     0.0     0.0
CO(0) + HV  -  CO(2)                        0.0     0.0     0.0     0.0
CO(1) + HV  -  CO(2)                        0.0     0.0     0.0     0.0
END
```

3.1.1 Species Cards

Each chemical species must be identified on a Species Card (or cards). Any set of up to 10 characters can be used as a species name, which must begin with a letter. Species names of more than 10 characters may be used by simply changing a parameter value and some related format statements in the

INTERPRETER. The primary purpose of the Species Cards is to identify the atmospheric species, the vibrational states included in the chemical kinetics mechanism for the selected radiating species, and finally the order in which arrays of species information are referenced in SHARC.

The first Species Card must contain the word SPECIES starting in Column 1. It is then followed by any number of cards which identify the species. Species symbols may appear anywhere on the card, and those on the same card must be separated by blank spaces. After all the species have been given, the following card must contain the word END starting in Column 1. The rules for Species Cards are summarized in Table 2.

TABLE 2. SUMMARY OF THE RULES FOR SPECIES CARDS.

1. The first (last) species Card must contain the word SPECIES (END) starting in Column 1. All other columns on this card are ignored.

2. Species names are composed of up to 10-character symbols. The names cannot begin with the characters +, -, =, a parenthesis, or a number.

3. Each species must be declared only once.

4. Each species which subsequently appears in a reaction must be declared.

5. The species declarations may appear anywhere on the cards.

6. Any number of species declarations may appear on a card. More than one card may be used.

7. Species declarations which appear on the same card must be separated by at least one blank space.

8. A species declaration which begins on one card may not continue to the next card.

9. One species declaration may end in Column 80 of one card and the next declaration may begin in Column 1 of the next card.

3.1.2 Reaction Mechanism Description

The reaction mechanism may involve any number of chemical reactions and/or energy transfer processes involving the species named on the Species Cards. If more than 6 species appear in a given reaction, some dimension statements in the INTERPRETER must be changed. In the present version, the energy transfer/reactive processes must be written explicitly in the forward and/or reverse directions. They may be three-body reactions with an arbitrary third body including the effects of enhanced third-body efficiencies. Processes may involve radiative relaxation or excitation (e.g., earthshine and/or sunshine).

The first Reaction Card must contain the word REACTIONS starting in Column 1. The following cards contain the reaction description together with the generalized Arrhenius/Schwartz-Slawsky-Herzfeld (SSH) rate coefficients. The reaction description is made up of Reaction Cards and perhaps Auxiliary Information Cards. The last card of the reaction description must contain the word END starting in Column 1.

3.1.2.1 Reaction Cards

Each Reaction Card is divided into two fields. The first field contains the symbolic description of the reaction while the second contains the Arrhenius/SSH rate coefficients. Both fields are format free, and blank spaces are ignored (except within a number or a species symbol). The reaction description, given in the first field, must be composed of the species symbols, coefficients, delimiters, and special symbols as summarized below.

Species Symbols
: Each species in a reaction is described with the unique sequence of characters exactly as they appear in the Species Cards.

Coefficients
: Any species symbol may be preceded by an integer coefficient. The coefficient simply has the meaning that there are that many moles of the particular species present as either reactants or products; e.g., 2OH is equivalent to OH + OH (non-integer coefficients are not allowed).

Delimiters

+ A plus sign is the delimiter between the reactant species and between the product species.

= Although an equality sign is still considered a legal delimiter (an equality sign formerly was the delimiter between the reactants and products for a reversible reaction), it currently has the same meaning as a minus sign.

- A minus sign is the delimiter between the reactants and products for an irreversible reaction.

Special Symbols

M The symbol M stands for an arbitrary third body. Normally it would appear as both a reactant and a product. However, it has the identical meaning even if it appears only as a reactant or a product. In other words, an M anywhere in the reaction description indicates that a third body is participating in the reaction. In any reaction containing an M, species are specified to have third-body efficiencies, in which case the next card(s) must be Auxiliary Information cards (described below).

HV The symbol HV indicates that photon radiation ($h\nu$) is present as either a reactant or a product. If an HV appears in a reaction description, the wavelength of the radiation may be specified on an Auxiliary Information Card (described later).

E The symbol E is used to represent an electron. Electrons are treated just like any other species except that they are not composed of elements.

[An open bracket means that any following characters through the beginning of the numbers for the Arrhenius coefficients are comments on the reaction. For example, the comment may be used to give a reference to the source of the reaction and rate data.

A special case for reaction descriptions occurs if two or more species names are identical except for the last character in one of the names being a +, -, or = (e.g., NO, NO+). The INTERPRETER always seeks to find the longest possible species name between delimiters (+, -, =). Therefore, the species NO may not be followed directly by a + as a delimiter since this would be confused with the species NO+. To prevent this confusion, the species NO must be separated from the delimiter + by at least one blank space (e.g., the reaction NO+O+M = NO2+M must be written as NO +O+M = NO2+M). However, NO+ +E+M = NO +M may just as well be written as NO++M+E = NO +M as long as NO++ is not a species. There is no ambiguity in the convention, and the worst that

can happen if the blank is not included before the delimiter is that an error message will be written from the INTERPRETER. The blank will have to be inserted by the user, but there is no possibility of having a reaction misinterpreted by the code and proceeding with an incorrect reaction.

The second field of the reaction card is used to define the Arrhenius/SSH rate coefficients A_i, β_i, C_i, and E_i. The rate constants are assumed to have the following functional form

$$k_i = A_i T^{\beta_i} \exp(-C_i/T^{1/3} - E_i/T) \quad . \tag{5}$$

The four numbers must appear in order: the first number being A_i, the second being β_i, the third being C_i, and the fourth being E_i. At least one blank space must separate the first number and the last symbol in the reaction or the comment. The four numbers must be separated by at least one blank space; be stated in either integer, floating point, or E format (e.g., 123 or 123.0 or 12.3E1) and have units associated with them. The default units for A_i are cgs (cm, sec, K, and molecules), the exact units depending on the reaction. The factor β_i is dimensionless. The default units for the SSH parameters and activation energies are $K^{1/3}$ and K, respectively.

Table 3 is a summary of the Reaction Card rules, and examples of some reaction cards are shown in Table 1.

TABLE 3. SUMMARY OF THE RULES FOR REACTION CARDS.

1. The first (last) Reaction Card must contain the word REACTIONS (END) starting in Column 1. All other columns on this card are ignored. (The END card would follow the last Auxiliary Information Card, if one was used for the last reaction).

2. The reaction description can begin anywhere on the card. All blank spaces, except those within species symbols and within coefficients, are ignored.

3. If some species names end with either the characters +, -, or =, and there are other species names which are identical to those except that they don't end in a +, -, or =, then in the reaction description the latter species names must be separated from +, -, or = delimiters by at least one blank space.

4. Each reaction description must use only one card and may not continue onto the next card.

5. Four numbers for the Arrhenius/SSH coefficients must appear on each Reaction Card, must occupy the last non-blank entries on the card, must be separated from the reaction description by at least one blank space, must be in the order (A_i, β_i, C_i, and E_i), and must be separated by at least one blank space. No blanks are allowed within the numbers themselves.

6. Comments are any characters following an open bracket and up to within one blank space of the first Arrhenius coefficient. The comments are written on on the output file along with the reaction description, but otherwise ignored within the code.

3.1.2.2 Auxiliary Information Cards

If a reaction contains an M as third body and/or it contains an HV to denote radiation, the card or cards following that reaction card may be Auxiliary Information Cards. These cards specify third-body efficiencies of certain species or specify radiation wavelength. Any species which acts as a third body must be declared as one of the species on the Species Cards.

The format of the card is a name (either a species name or the characters HV) followed by a number (either integer, floating point, or E format delimited by slashes(/). For enhanced third-body efficiencies, the name is

the species name of the enhanced third body, and the number is its enhanced efficiency factor. For wavelength specification, the symbols HV are followed by the wavelength.

Any number of third-body efficiencies may be included, and each Auxiliary Information Card may contain one or more efficiency factors. If more than 6 species have are specified as third bodies in any one reaction, some dimensioning needs to be changed in the INTERPRETER Also, the radiation wavelength may appear on a separate card, or it may be on the same card as a third-body efficiencies specification. Thus more than one Auxiliary Information Card may be used for any one reaction. Examples of auxiliary information are shown in Table 1. The above rules are summarized in Table 4.

TABLE 4. SUMMARY OF THE RULES FOR AUXILIARY INFORMATION CARDS.

1.	Auxiliary Information Cards may only follow Reaction Cards which contain an M or an HV.
2.	A species may have only one third-body efficiency associated with it in any one reaction.
3.	Only one radiation wavelength may be declared in a reaction.
4.	The order in which the enhanced third-body declarations are given is the order in which arrays of third-body information are referenced in the subroutine package. The order in which the radiation wavelength appears with respect to enhanced third-body information is unimportant.
5.	Third-body (or wavelength) information may appear anywhere on the card.
6.	Any number of third-body efficiencies may appear on a card. Thus more than one card may be used.
7.	Third-body declarations or radiation wavelength specifications which appear on the same card must be separated by at least one blank space.
8.	A third-body (or wavelength) declaration which begins on one card may not continue on to the next card.
9.	One declaration (third-body efficiency or wavelength) may end in column 80 of one card, and the next declaration may begin in Column 1 of the next card.
10.	Any blank spaces between the species symbol (or HV) and the first slash are ignored, and any blanks between the slashes and the efficiency factor (or wavelength) are also ignored. However, no blank spaces are allowed within the factor (or wavelength).

3.2 Molecular States Files

The molecular states files are designed to supply the following information to SHARC:

- Identification of the molecular radiator;
- Definition of the vibrational energies and degeneracies associated with the vibrational states included in the chemical kinetics mechanism;

- Definition of the vibrational transitions (i.e., molecular bands) which will be treated by NEMESIS and SPCRAD. Note that a transition may be considered by NEMESIS but not by SPCRAD; and

- Definition of the effective earthshine temperature for each transition considered by NEMESIS.

The molecular states file is written in ASCII format. The information is input in an 80 column format and is format free. The SHARC CO molecular states file is given in Table 5. As the structure of the molecular states file is described, the reader should refer back to Table 5 as an example of the file organization.

TABLE 5. SHARC CO MOLECULAR STATES INPUT FILE.

```
CO VIBRATIONAL STATES AND TRANSITIONS
ENERGIES AND DEGENERACIES
 0      0.000     1
 1   2143.272     1
 2   4260.063     1
END
TRANSITIONS
 1-0      230.0     1
 2-0      280.0     1
 2-1      280.0     1
END
```

The first line in the states file identifies the radiating species (which must be the first entry on this line) being considered by SHARC. Any information contained on this line after the radiating species identification is treated only as a comment and is subsequently ignored by the code. The next line must contain the identifier ENERGIES starting in Column 1, and thus signals the start of the list of vibrational-state energies and degeneracies. This line is followed by any number of lines which must each contain three numbers which identify the particular vibrational state (using the standard AFGL notation), the energy of that state (in cm^{-1}), and the degeneracy of that state, respectively. The three numbers must be separated by at least one blank, and may be integer, floating point, or exponential format. After all

the vibrational states have been listed, the next line must contain the word END beginning in Column 1.

The next section of the molecular states file lists the vibrational transitions information. The first line following the END card must contain the word TRANSITIONS starting in Column 1. This line is followed by as many lines as necessary to identify: each vibrational transition considered by NEMESIS, the effective earthshine temperature (in K) for the transition, and whether or not to compute the radiance along the observer LOS for the transition. The vibrational transition is listed as "U-L" where "U" denotes the upper state and "L" denotes the lower state for the transition. The minus, "-", is the delimiter which separates the upper and lower states in the transition. *It is important to note that a transition in the molecular states file must have the corresponding radiative relaxation and excitation processes listed in the chemical kinetics mechanism (compare Tables 1 and 5).* The LOS radiance option is defined as follows:

- 0 - Radiance is not computed for this transition,
- 1 - Radiance is computed for this transition.

Although the radiance may not be computed for a particular transition, it may be important to include the transition in the states file for the NEMESIS calculation. The vibrational transition, effective earthshine temperature, and LOS radiance option must be separated by at least one blank. After all the vibrational transitions information have been given, a line containing the word END beginning in Column 1 must follow.

3.3 Molecular Bands Files

The molecular bands files are used to input line strength information necessary for the CHEMKIN and NEMESIS modules. CHEMKIN uses the information to obtain the altitude-dependent earthshine and sunshine excitation rates, while NEMESIS uses the information to calculate the enhancement of molecular excited-state populations due to radiative trapping and atmospheric emission.

Although both CHEMKIN and NEMESIS could directly use the modified HITRAN line compilation, this would be extremely time consuming due to the large

number of lines. It is much more efficient to discretize the line strength distribution. Finite width bins are chosen in which a single average line is determined and a degeneracy equal to the actual number of lines from the exact distribution is assigned to the average line. In the limit of infinitesimal width bins the exact line strength distribution is recovered. For reasonable choices of bin widths (presently three bins per order of magnitude), the number of lines that need be considered can be reduced by several orders of magnitude without significant loss of computational accuracy. An additional quantity, the cumulative line strength probability sum, is used to choose a line strength value for each Monte Carlo simulated emission event in NEMESIS.

The molecular bands file indicates the vibrational transition along with the number of lines in a bin, the average strength in the bin, and the probability of finding a line in the bin. This information suffices to completely characterize the discretized line strength distribution. The file is written in ASCII format assuming an 80 column line and is format free. The SHARC CO molecular bands file is given in Table 6. Again, the reader should refer back to Table 6 as an example of the file organization.

The first line in the bands file identifies the molecular species (which must be the first entry on this line) for which the file has been created. The information contained on this line after the species identification is treated only as a comment and is ignored by the code. The molecular species is checked against the radiating species identified in the molecular states file to ensure a consistent set of files is being used. The next line contains the vibrational transition which is then followed by a list of the line strength parameters. As in the molecular states file, the vibrational transition is listed as "U-L" where "U" denotes the upper state, and "L" denotes the lower state for the transition. The minus, "-", is the delimiter which separates the upper and lower states in the transition. Each transition listed in the molecular states file must have a corresponding entry in the molecular bands file. The lines following vibrational transition describe the line strength distribution. Each line must contain four numbers which characterize the particular line strength distribution bin. The entries must be in the following order: (1) the bin number (not currently used by the code), (2) the number of lines in the bin, (3) the average line strength in

TABLE 6. SHARC CO MOLECULAR BANDS INPUT FILE.

CO	BAND	TRANSITIONS			
	1 -	0	G	S	PSUM
		1	2	.506E-18	.1030
		2	21	.350E-18	.8510
		3	7	.136E-18	.9479
		4	4	.710E-19	.9768
		5	5	.313E-19	.9927
		6	2	.142E-19	.9956
		7	4	.716E-20	.9985
		8	2	.322E-20	.9992
		9	3	.162E-20	.9997
		10	7	.441E-21	1.0000
END					
	2 -	0	G	S	PSUM
		1	18	.307E-20	.7344
		2	8	.157E-20	.9010
		3	6	.802E-21	.9649
		4	5	.349E-21	.9881
		5	3	.156E-21	.9943
		6	3	.773E-22	.9974
		7	4	.336E-22	.9992
		8	2	.145E-22	.9995
		9	3	.725E-23	.9998
		10	7	.178E-23	1.0000
END					
	2 -	1	G	S	PSUM
		1	1	.101E-17	.0526
		2	18	.766E-18	.7741
		3	10	.326E-18	.9445
		4	4	.144E-18	.9747
		5	3	.768E-19	.9868
		6	5	.386E-19	.9969
		7	4	.149E-19	1.0000
END					

the bin (cm^{-1}/molecule/cm^{-2}), and (4) the cumulative probability corresponding to the bin. The cumulative probability for bin I is

$$\sum_{i=1}^{I} P_i \tag{6}$$

where P_i is the probability of finding a line of a given strength in bin i. Thus for the last bin the cumulative probability must be unity. The four

numbers contained on the line must be separated by at least one blank, and may be integer, floating point, or exponential format. After all the line strength bins have been listed for the particular transition, the next line must contain the word END beginning in Column 1.

3.4 Modified HITRAN Line File

The augmented HITRAN[5] line file used by SHARC includes line parameters for CO, CO_2, H_2O, O_3, and NO. There are a total of 95,659 lines in the file, although the bands currently supported by SHARC will use 72,314 of the lines. The other lines are for transitions which will be supported in future versions of SHARC. The lines in the file have been modified to speed up the LOS spectral radiance calculation. The first modification was to separate the total energy of the lower state, E", into vibrational, E_V, and rotational, E_R, components. SHARC requires the separate E_V and E_R to properly scale the line strength since there are different vibrational and rotational temperatures. Computational time is saved by storing E_V and E_R rather than re-calculating them in the spectral radiance module.

The standard HITRAN line strengths have also been modified. The temperature-dependent scaling factors evaluated at the reference temperature, T_s = 296 K, have been removed from the strengths. This modification speeds up the spectral radiance calculation by eliminating the calculations which depend on T_s. Although the CPU savings realized by removing T_s is fairly small per line, a typical calculation uses thousands of lines and, therefore, the total savings can be significant. The line strength, SR, stored in the database is given by:

$$SR = S(T_s)\ Q_v(T_s)\ Q_r(T_s)\ \exp(C_2 \frac{E''}{T_s})\ [1 - \exp(-C_2 \frac{W_o}{T_s})]^{-1} \tag{7}$$

where $S(T_s)$ is the standard HITRAN line strength, W_o is the transition wavenumber, Q_v and Q_r are the vibrational and rotational partition functions, respectively.

The following database parameters are used in the spectral radiance module of SHARC:

MOL - AFGL molecular species identification label

ISO - AFGL molecular species isotope identification label

W_o - transition frequency (cm^{-1})

SR - modified line strength (cm^{-1}/molecule/cm^{-2})

GAM - Lorentz halfwidth (cm^{-1})

E" - total energy of lower state (cm^{-1})

E_V - vibrational energy of lower state (cm^{-1})

E_R - rotational energy of lower state (cm^{-1})

IUP - upper state vibrational label

ILOW - lower state vibrational label.

In addition to the above parameters, there are a few parameters which are in the database and are not currently used by SHARC, but are included to support future extensions. These include a self-broadening halfwidth, a coefficient of temperature dependence of air-broadened halfwidth, and upper and lower state local quanta indices. An example of the database is given in Table 7, we have included only the parameters currently used by SHARC. This part of the line file includes lines for H_2O (MOL=1), CO_2 (MOL=2), and NO (MOL=8).

The line file used by SHARC is written in binary format. Using a binary representation of the file saves storage space and makes the reading time shorter than if the file was stored in an ASCII format. The file is provided on the SHARC computer tape in an ASCII format along with a program which converts the file to binary.

TABLE 7. PART OF SHARC LINE PARAMETER DATABASE.

MOL	ISO	W_o	SR	GAM	E"	E_V	E_R	IUP	ILOW
1	1	1950.4490	.432E-16	.0907	2000.8660	1594.7500	406.1160	4	2
2	1	1950.6992	.727E-21	.0727	197.4163	.0000	197.4163	6	1
2	1	1950.8227	.212E-19	.0646	1308.6709	667.3800	641.2909	11	2
8	1	1950.8421	.149E-18	.0500	4514.8540	3724.1699	790.6841	4	13
8	1	1950.8650	.103E-15	.0490	1189.3781	.0000	1189.3781	2	1
8	1	1950.8710	.103E-15	.0490	1189.4390	.0000	1189.4390	2	1
8	1	1950.9238	.248E-19	.0610	3737.2720	3724.1699	13.1021	4	13
2	1	1950.9821	.191E-19	.0649	1276.4469	667.3800	609.0669	11	2
1	1	1951.1300	.113E-17	.0620	447.2520	.0000	447.2520	2	1
2	1	1951.1772	.199E-20	.0892	1390.5258	1388.1851	2.3407	19	5
2	1	1951.1910	.358E-20	.0876	1395.9884	1388.1851	7.8033	19	5
2	1	1951.2126	.518E-20	.0860	1404.5724	1388.1851	16.3873	19	5
2	1	1951.2421	.677E-20	.0843	1416.2777	1388.1851	28.0927	19	5
2	1	1951.2794	.835E-20	.0826	1431.1040	1388.1851	42.9189	19	5
2	1	1951.3244	.996E-20	.0810	1449.0513	1388.1851	60.8662	19	5
3	1	1951.3430	.679E-18	.0638	652.3090	.0000	652.3090	14	1
2	1	1951.3772	.115E-19	.0793	1470.1191	1388.1851	81.9341	19	5
1	1	1951.4230	.137E-16	.0820	1907.4520	1594.7500	312.7020	4	2
2	1	1951.4375	.131E-19	.0777	1494.3074	1388.1851	106.1223	19	5
2	1	1951.5055	.147E-19	.0761	1521.6157	1388.1851	133.4307	19	5
2	1	1951.5810	.163E-19	.0747	1552.0435	1388.1851	163.8584	19	5
2	1	1951.6639	.179E-19	.0733	1585.5906	1388.1851	197.4055	19	5
2	1	1951.7541	.195E-19	.0721	1622.2563	1388.1851	234.0713	19	5
8	1	1951.7804	.151E-18	.0500	4588.4712	3724.1699	864.3013	4	13
8	1	1951.8076	.551E-19	.0570	5738.5718	5544.1250	194.4468	5	14
2	1	1951.8515	.211E-19	.0710	1662.0403	1388.1851	273.8552	19	5
2	1	1951.9560	.227E-19	.0699	1704.9419	1388.1851	316.7568	19	5

3.5 Model Atmosphere Files

The atmospheric models supplied with SHARC are based on the AFGL HAIRM[6] atmospheric models. There are currently daytime and nighttime models for:

- 1976 standard atmosphere,
- 15^o latitude annual,
- 30^o latitude summer, winter,
- 45^o latitude spring/fall, summer, winter, and
- 60^o latitude summer, winter,

for exo-atmospheric temperatures of 600, 1000 and 1500 K. These models include temperature and number densities for N_2, O_2, O, CH_4, CO_2, H_2O, NO, N_2O, O_3, and CO as a function of altitude. The profiles are layered into 60

homogeneous layers (61 layer boundaries) defined in 2 km increments from 60 to 150 km and in 10 km increments from 150 to 300 km.

The model atmosphere file is contained in an 80 column, format free ASCII file. The input file is checked for proper syntax and self-explanatory diagnostic messages are written to the SHARC error file if unacceptable syntax is encountered.

The user can define a new atmosphere file by following a set of simple rules. A SHARC atmospheric file is structured as a series of input parameter identification cards followed by the actual input values (at least one) and an END card that denotes the end of the parameter input.

As an example, the daytime 1976 Standard Atmosphere Model input file provided with SHARC is shown in Table 8. As the various input parameters are described, it should help the user to refer back to Table 8.

TABLE 8. CURRENT SHARC 1976 STANDARD MODEL ATMOSPHERE INPUT FILE.

```
ATMOSPHERE NAME
SAT1976.DAT
END
NUMBER OF BOUNDARIES
 61
END
DAY-NIGHT VARIABLE AND EXOATMOSPHERIC TEMPERATURE
 DAY 1000.
END
SPECIES
O2 O CH4 CO2 H2O NO N2O CO N2 O3
END
ALTITUDES OF BOUNDARIES
 60  62  64  66  68  70  72  74  76  78  80  82  84  86  88  90
 92  94  96  98 100 102 104 106 108 110 112 114 116 118 120 122
124 126 128 130 132 134 136 138 140 142 144 146 148 150 160 170
180 190 200 210 220 230 240 250 260 270 280 290 300
END
TEMPERATURES
  2.4706E+02 2.4157E+02 2.3607E+02 2.3058E+02 2.2509E+02 2.1959E+02
  2.1426E+02 2.1035E+02 2.0643E+02 2.0252E+02 1.9861E+02 1.9470E+02
  1.9078E+02 1.8687E+02 1.8687E+02 1.8687E+02 1.8698E+02 1.8774E+02
  1.8931E+02 1.9172E+02 1.9508E+02 1.9953E+02 2.0531E+02 2.1289E+02
  2.2329E+02 2.4000E+02 2.6400E+02 2.8800E+02 3.1200E+02 3.3600E+02
  3.6000E+02 3.8355E+02 4.0622E+02 4.2804E+02 4.4904E+02 4.6927E+02
  4.8838E+02 5.0748E+02 5.2519E+02 5.4290E+02 5.5932E+02 5.7573E+02
```

```
   5.9095E+02 6.0617E+02 6.2028E+02 6.3439E+02 6.9629E+02 7.4757E+02
   7.9007E+02 8.2531E+02 8.5456E+02 8.7679E+02 8.9901E+02 9.0739E+02
   9.1578E+02 9.3338E+02 9.5099E+02 9.5724E+02 9.6350E+02 9.6976E+02
   9.7601E+02
END
N2 DENSITIES
   5.0401E+15 3.9179E+15 3.0285E+15 2.3272E+15 1.7774E+15 1.3487E+15
   1.0158E+15 7.5547E+14 5.5885E+14 4.1110E+14 3.0067E+14 2.1859E+14
   1.5792E+14 1.1335E+14 7.9416E+13 5.5653E+13 3.8990E+13 2.7250E+13
   1.9010E+13 1.3255E+13 9.2490E+12 6.4652E+12 4.5314E+12 3.1853E+12
   2.2430E+12 1.5690E+12 1.1070E+12 8.0527E+11 6.0096E+11 4.5838E+11
   3.5627E+11 2.8177E+11 2.2647E+11 1.8454E+11 1.5219E+11 1.2683E+11
   1.0674E+11 9.0442E+10 7.7300E+10 6.6417E+10 5.7475E+10 4.9948E+10
   4.3665E+10 3.8305E+10 3.3772E+10 2.9862E+10 1.6954E+10 1.0227E+10
   6.4440E+09 4.1942E+09 2.7983E+09 1.9071E+09 1.3137E+09 9.2566E+08
   6.5502E+08 4.6161E+08 3.2777E+08 2.3676E+08 1.7154E+08 1.2467E+08
   9.0872E+07
END
O2 DENSITIES
   1.3521E+15 1.0510E+15 8.1245E+14 6.2433E+14 4.7682E+14 3.6181E+14
   2.7251E+14 2.0267E+14 1.4992E+14 1.1029E+14 8.0661E+13 5.8641E+13
   4.2366E+13 3.0409E+13 2.1305E+13 1.4930E+13 1.0460E+13 7.3104E+12
   5.0997E+12 3.5560E+12 2.4812E+12 1.7344E+12 1.2156E+12 8.5452E+11
   6.0174E+11 4.2093E+11 2.8647E+11 2.0163E+11 1.4599E+11 1.0828E+11
   8.1997E+10 6.3292E+10 4.9716E+10 3.9644E+10 3.2027E+10 2.6169E+10
   2.1614E+10 1.7985E+10 1.5105E+10 1.2762E+10 1.0864E+10 9.2931E+09
   7.9998E+09 6.9133E+09 6.0066E+09 5.2357E+09 2.7792E+09 1.5760E+09
   9.3719E+08 5.7740E+08 3.6549E+08 2.3673E+08 1.5519E+08 1.0418E+08
   7.0274E+07 4.7246E+07 3.2037E+07 2.2115E+07 1.5320E+07 1.0649E+07
   7.4278E+06
END
O DENSITIES
   1.2000E+10 1.3291E+10 1.4720E+10 1.6304E+10 1.8058E+10 2.0000E+10
   2.4915E+10 3.1037E+10 3.8664E+10 4.8164E+10 6.0000E+10 6.7650E+10
   7.6275E+10 8.6000E+10 1.5100E+11 2.4400E+11 3.4300E+11 4.1600E+11
   4.4700E+11 4.4800E+11 4.3000E+11 4.0100E+11 3.6200E+11 3.1900E+11
   2.7500E+11 2.3000E+11 1.8900E+11 1.5600E+11 1.3000E+11 1.1000E+11
   9.2800E+10 7.9883E+10 6.8765E+10 5.9812E+10 5.2567E+10 4.6200E+10
   4.1344E+10 3.6998E+10 3.3303E+10 3.0153E+10 2.7300E+10 2.4951E+10
   2.2803E+10 2.0934E+10 1.9303E+10 1.7800E+10 1.2400E+10 9.0000E+09
   6.7500E+09 5.1800E+09 4.0500E+09 3.2353E+09 2.5845E+09 2.0869E+09
   1.7032E+09 1.3900E+09 1.1471E+09 9.4668E+08 7.8444E+08 6.5265E+08
   5.4300E+08
END
CH4 DENSITIES
   6.0287E+13 4.6863E+13 3.6225E+13 2.7837E+13 2.1260E+13 1.6132E+13
   1.2151E+13 9.0365E+12 6.6846E+12 4.9174E+12 3.5965E+12 2.6146E+12
   1.8890E+12 1.3558E+12 9.4994E+11 6.6570E+11 4.6638E+11 3.2595E+11
   2.2738E+11 1.5855E+11 1.1063E+11 7.7334E+10 5.4202E+10 3.8101E+10
   2.6830E+10 1.8768E+10 1.1886E+10 7.8350E+09 5.3408E+09 3.7462E+09
   2.6932E+09 1.9803E+09 1.4860E+09 1.1348E+09 8.7986E+08 6.9127E+08
   5.4987E+08 4.4130E+08 3.5797E+08 2.9242E+08 2.4096E+08 1.9970E+08
```

```
  1.6670E+08 1.3981E+08 1.1798E+08 9.9943E+07 4.6388E+07 2.3255E+07
  1.2322E+07 6.8043E+06 3.8779E+06 2.2693E+06 1.3479E+06 8.2143E+05
  5.0361E+05 3.0824E+05 1.9067E+05 1.2024E+05 7.6155E+04 4.8442E+04
  3.0945E+04
END
CO2 DENSITIES
  2.0268E+12 1.5755E+12 1.2178E+12 9.3586E+11 7.1474E+11 5.4235E+11
  4.0849E+11 3.0380E+11 2.2473E+11 1.6532E+11 1.2091E+11 8.7901E+10
  6.3505E+10 4.5582E+10 3.1936E+10 2.2380E+10 1.5679E+10 1.0958E+10
  7.6444E+09 5.3303E+09 3.7193E+09 2.5999E+09 1.8222E+09 1.2809E+09
  9.0199E+08 6.3096E+08 3.8519E+08 2.4553E+08 1.6228E+08 1.1063E+08
  7.7452E+07 5.5552E+07 4.0724E+07 3.0420E+07 2.3095E+07 1.7785E+07
  1.3878E+07 1.0934E+07 8.7128E+06 6.9961E+06 5.6699E+06 4.6236E+06
  3.7995E+06 3.1382E+06 2.6089E+06 2.1781E+06 9.4394E+05 4.4431E+05
  2.2195E+05 1.1589E+05 6.2601E+04 3.4781E+04 1.9643E+04 1.1394E+04
  6.6526E+03 3.8811E+03 2.2906E+03 1.3793E+03 8.3449E+02 5.0729E+02
  3.0983E+02
END
H2O DENSITIES
  3.1197E+10 2.3833E+10 1.8099E+10 1.3412E+10 1.0053E+10 7.3407E+09
  5.3121E+09 3.7088E+09 2.5646E+09 1.7549E+09 1.1552E+09 7.2318E+08
  4.3819E+08 2.6614E+08 1.5256E+08 8.9093E+07 4.7853E+07 2.6174E+07
  1.3187E+07 5.6585E+06 2.4677E+06 1.3800E+06 8.7048E+05 5.6092E+05
  3.7104E+05 2.5118E+05 1.9400E+05 1.5326E+05 1.2339E+05 1.0096E+05
  8.3768E+04 7.0425E+04 5.9953E+04 5.1585E+04 4.4798E+04 3.9220E+04
  3.4608E+04 3.0688E+04 2.7403E+04 2.4562E+04 2.2144E+04 2.0025E+04
  1.8196E+04 1.6575E+04 1.5161E+04 1.3895E+04 9.3398E+03 6.5788E+03
  4.7925E+03 3.5798E+03 2.7255E+03 2.1104E+03 1.6458E+03 1.3097E+03
  1.0451E+03 8.2883E+02 6.6058E+02 5.3465E+02 4.3358E+02 3.5230E+02
  2.8683E+02
END
NO DENSITIES
  9.0000E+07 7.2000E+07 5.8000E+07 4.6000E+07 3.7000E+07 2.9000E+07
  2.3000E+07 1.8000E+07 1.4000E+07 1.1500E+07 9.6000E+06 8.7000E+06
  8.2000E+06 8.7000E+06 1.0500E+07 1.4000E+07 1.8000E+07 2.3000E+07
  3.0000E+07 3.6000E+07 4.0000E+07 4.2000E+07 4.4000E+07 4.5000E+07
  4.4000E+07 4.3000E+07 4.2000E+07 4.0000E+07 3.9000E+07 3.7000E+07
  3.6000E+07 3.4769E+07 3.3579E+07 3.2377E+07 3.1166E+07 3.0000E+07
  2.8691E+07 2.7438E+07 2.6241E+07 2.5095E+07 2.4000E+07 2.2783E+07
  2.1627E+07 2.0530E+07 1.9489E+07 1.8500E+07 1.3500E+07 8.8105E+06
  5.7500E+06 3.6759E+06 2.3500E+06 1.6011E+06 1.0909E+06 7.4322E+05
  5.0637E+05 3.4500E+05 2.4436E+05 1.7308E+05 1.2259E+05 8.6829E+04
  6.1500E+04
END
N2O DENSITIES
  6.4547E+10 5.0175E+10 3.8785E+10 2.9804E+10 2.2762E+10 1.7272E+10
  1.3009E+10 9.6751E+09 7.1570E+09 5.2648E+09 3.8506E+09 2.7994E+09
  2.0225E+09 1.4517E+09 1.0171E+09 7.1274E+08 4.9934E+08 3.4899E+08
  2.4345E+08 1.6976E+08 1.1845E+08 8.2798E+07 5.8032E+07 4.0793E+07
  2.8726E+07 2.0094E+07 1.3924E+07 9.9633E+06 7.3239E+06 5.5086E+06
  4.2261E+06 3.3020E+06 2.6236E+06 2.1149E+06 1.7263E+06 1.4245E+06
  1.1876E+06 9.9721E+05 8.4490E+05 7.1985E+05 6.1786E+05 5.3271E+05
```

```
  4.6212E+05 4.0237E+05 3.5216E+05 3.0917E+05 1.6973E+05 9.9267E+04
  6.0764E+04 3.8478E+04 2.5006E+04 1.6614E+04 1.1164E+04 7.6784E+03
  5.3049E+03 3.6515E+03 2.5337E+03 1.7892E+03 1.2676E+03 9.0093E+02
  6.4239E+02
END
O3 DENSITIES
  7.3300E+09 4.4000E+09 2.4000E+09 1.1000E+09 5.2000E+08 2.0000E+08
  9.0000E+07 4.6000E+07 2.7000E+07 1.9000E+07 1.8000E+07 2.2000E+07
  3.8000E+07 4.5000E+07 4.5000E+07 3.8000E+07 2.8000E+07 2.0000E+07
  1.4000E+07 9.0000E+06 5.0000E+06 3.4951E+06 2.4497E+06 1.7220E+06
  1.2126E+06 8.4823E+05 4.9947E+05 3.0806E+05 1.9755E+05 1.3095E+05
  8.9319E+04 6.2521E+04 4.4794E+04 3.2742E+04 2.4351E+04 1.8386E+04
  1.4079E+04 1.0893E+04 8.5299E+03 6.7346E+03 5.3694E+03 4.3097E+03
  3.4873E+03 2.8374E+03 2.3245E+03 1.9131E+03 7.7511E+02 3.4296E+02
  1.6168E+02 7.9913E+01 4.0952E+01 2.1623E+01 1.1622E+01 6.4220E+00
  3.5742E+00 1.9892E+00 1.1211E+00 6.4513E-01 3.7317E-01 2.1697E-01
  1.2680E-01
END
CO DENSITIES
  9.0366E+08 1.0035E+09 1.0860E+09 1.1922E+09 1.2291E+09 1.2090E+09
  1.2489E+09 1.2578E+09 1.2167E+09 1.1583E+09 1.1552E+09 1.1757E+09
  1.1124E+09 1.1323E+09 1.0680E+09 1.0691E+09 1.0486E+09 9.7717E+08
  8.7642E+08 7.8090E+08 7.1070E+08 5.7959E+08 4.6426E+08 3.6714E+08
  2.7577E+08 2.0094E+08 1.4178E+08 1.0313E+08 7.6969E+07 5.8709E+07
  4.5631E+07 3.6091E+07 2.9007E+07 2.3638E+07 1.9494E+07 1.6245E+07
  1.3673E+07 1.1585E+07 9.9018E+06 8.5079E+06 7.3624E+06 6.3984E+06
  5.5935E+06 4.9070E+06 4.3264E+06 3.8255E+06 2.1721E+06 1.3103E+06
  8.2563E+05 5.3739E+05 3.5856E+05 2.4437E+05 1.6834E+05 1.1862E+05
  8.3942E+04 5.9158E+04 4.2006E+04 3.0343E+04 2.1986E+04 1.5979E+04
  1.1648E+04
END
```

The following input parameter identification cards must be contained in the user-defined atmospheric model file in the order listed:

- ATMOSPHERE NAME Card
- NUMBER OF LAYER BOUNDARIES Card
- DAY-NIGHT VARIABLE AND EXOATMOSPHERIC TEMPERATURE Card
- SPECIES Card
- ALTITUDES Card
- TEMPERATURES Card
- SPECIES DENSITIES Card.

Each input parameter identification card must start in Column 1. After the appropriate data corresponding to the identification card has been entered into the file, the next line must contain the word END beginning in Column 1.

The information required after each parameter identification card is detailed below.

The line following the ATMOSPHERE NAME card must contain the alphanumeric name of the atmospheric file being used. After the END card (and following the NUMBER OF LAYER BOUNDARIES card), the number of layer boundary points should be entered. There must be at least two layer boundaries, and the current maximum is 61 boundaries. Next the DAY-NIGHT parameter and the EXOATMOSPHERIC TEMPERATURE should be defined exactly in the order stated and separated by at least a blank space. The DAY-NIGHT parameter is entered as either DAY or NIGHT. For a user-defined atmosphere the DAY-NIGHT parameter must be present, but it is not actually used by SHARC. Also, for a user-defined atmosphere the exoatmospheric temperature should be input as 0.0. After the SPECIES card, a list of atmospheric species for which number densities are given is input. This list of species must include all molecular species desired in the model atmosphere. The same rules apply to entering the atmospheric species as those given for the INTERPRETER (see Subsection 3.1.1). <u>Also, each species listed in the atmosphere file must be listed as a species in the interpreter file</u>. The next input considered is the altitudes of the layer boundaries. Any number of lines may be entered to define the layer altitudes. The layers must be entered in <u>ascending</u> order. The input units are km and are converted to cm internally. Next the kinetic temperatures and species number densities are entered in such a way as to correspond to the layer boundary altitudes. The number of entries for the temperatures and each species number densities must equal the value of the parameter entered for the number of layer boundaries. The temperatures are input in degrees Kelvin and the number densities are input in molecules/cm^3. After the line containing the END card for the TEMPERATURE data, a card with one of the valid atmospheric species names (followed by a blank and the word DENSITIES) indicates the beginning of the atmospheric number densities input for this species, see Table 8 for clarification. Again, this data is followed by the word END beginning in Column 1. The procedure for the atmospheric species is continued until number densities have been defined for all atmospheric species listed in the SPECIES section of the file.

4. RUNNING SHARC

4.1 Overview

This section is intended as a ready reference for the user who has some familiarity with running SHARC, but may want a quick tutorial for the execution procedure. In addition to providing somewhat brief instructions taking the user from the input files through to a plot of spectral radiance, file names used by the INTERPRETER, SHARC, and the PLOTTING PACKAGE are also presented. Of course, for detailed instructions concerning the creation of input files or definition of input variables, the user should refer to the appropriate sections of this report.

Prior to running SHARC, the "linking" files must be created for each molecular radiator. This is accomplished by running the INTERPRETER once for each radiator. The INTERPRETER expects an ASCII input file named INTERP.INP, which contains the chemical kinetics mechanism for producing vibrationally excited states for the selected radiator. The structure for this input file is discussed in some detail in Section 3.1. After executing the INTERPRETER, two output files are created: INTERP.OUT and INTERP.LNK. The file INTERP.OUT is an ASCII file and contains information from the input file. The user should check this file to ensure that the INTERPRETER was successfully executed. Any error messages created during program execution will be written to this file. The file INTERP.LNK is a binary file (i.e., the "linking" file) which contains the chemical kinetics information required by SHARC. This file is only created if no errors were encountered during the INTERPRETER execution.

There are five chemical kinetics mechanism input files which are currently supplied with SHARC for CO, NO, CO_2, H_2O, and O_3. The input file names are summarized in Table 9. In order to create a "linking" file for one of the radiators, say CO, one would proceed as follows: (1) copy the file COKIN.DAT to INTERP.INP, (2) execute the INTERPRETER, (3) rename INTERP.OUT to COOUT.DAT, and (4) rename INTERP.LNK to COLINK.DAT. The file COLINK.DAT would then be used as the "linking" file for SHARC. This procedure should be carried out for each molecular radiator.

TABLE 9. SUMMARY OF THE FILES USED BY THE INTERPRETER.

INPUT	OUTPUT	LINKING
H2OKIN.DAT	H2OOUT.DAT	H2OLINK.DAT
CO2KIN.DAT	CO2OUT.DAT	CO2LINK.DAT
O3KIN.DAT	O3OUT.DAT	O3LINK.DAT
COKIN.DAT	COOUT.DAT	COLINK.DAT
NOKIN.DAT	NOOUT.DAT	NOLINK.DAT

To execute SHARC the user must first prepare 18 separate input files. Many of these files require no modification by the user unless the user desires to change and/or supplement the AFGL database provided with SHARC. The SHARC input and output files are summarized in Table 10. These files include:

- 5 Linking files (one for each molecular emitter),
- 5 States files (one for each molecular emitter),
- 5 Bands files (one for each molecular emitter),
- 1 Model atmosphere profile file (9 are provided),
- SHARC HITRAN file (binary version), and
- SHARC input file (SHARC.INP).

These files have been described in detail in Sections 3 and 4 of this manual. The Linking files are generated by running the INTERPRETER as described above. The states, bands, and model atmosphere files are provided on the SHARC computer tape, and require no modification. The binary SHARC HITRAN file is generated from an ASCII file provided on the SHARC computer tape. Forming this binary file and compiling/linking SHARC are described in detail in Appendix A. Finally the SHARC input file, SHARC.INP, must be available to SHARC, or a new SHARC.INP will be created. The input module and the SHARC.INP files are described in detail in Sections 4.2 - 4.4.

Once the user has all of the above files prepared, SHARC can be executed. SHARC can run in either an interactive or batch/background mode of operation. The interactive mode is useful in setting up new calculation scenarios, since the interactive input module can walk the user through the necessary input

variables. For more experienced users, SHARC can be executed by circumventing the input module and making all changes to the SHARC.INP file with an editor.

The input module of SHARC is based on a menu-query system derived from the AFGL Auroral Atmospheric Radiance Code.[2] In general, typing a 0 will take the user up a level in the menu system, while typing a number greater than 0 will allow the user to input new information or enter a submenu. When a submenu is entered the current values for input variables are displayed to the user. This allows the user to scan the current input parameter values and decide if anything needs to be changed. There is a sample interactive session in Section 4.2.

After a successful SHARC calculation there will be four new ASCII output files. These files are:

- Error file (described in Section 5.1),
- General output file (described in Section 5.2),
- Population file (described in Section 5.3), and
- Plot file (described in Section 5.4).

The Error file, called SHARC.ERR should be empty if the calculation was performed without errors or warnings. The user should always check this file to insure the calculation was performed correctly. The general output file, called SHARC.OUT, includes a summary of the calculation. The plotting file contains the spectral radiance ($W/sr/cm^2/cm^{-1}$) as a function of frequency (cm^{-1}) and is used as an input file for the SHARC plotting package or a user provided plotting package. The SHARC plotting package is an interactive menu-query plotting package and is described in detail in Section 6. The population file contains all of the necessary excited-state population information to allow the user to skip the CHEMKIN/NEMESIS modules of SHARC and go directly to the geometry and spectral radiance modules. Populations only depend on the model atmosphere, day/night conditions and solar zenith angle. Therefore, the same populations can be used for many different LOS's and bandpass configurations. This can save a large amount of computer time and gives the user the opportunity to set up a library of populations for future or often-used scenarios.

TABLE 10. SUMMARY OF THE FILES USED BY SHARC.

LINKING	STATES	BANDS	INPUT	OUTPUT
COLINK.DAT	COSTAT.DAT	COBAND.DAT	SHARC.INP	SHARC.ERR
NOLINK.DAT	NOSTAT.DAT	NOBAND.DAT	SHARC.LIN	SHARC.OUT
CO2LINK.DAT	CO2STAT.DAT	CO2BAND.DAT	SAT1976.DAT[%]	SHARC.SPC
H2OLINK.DAT	H2OSTAT.DAT	H2OBAND.DAT		POPNEW.DAT[*]
O3LINK.DAT	O3STAT.DAT	O3BAND.DAT		

% This is one of the 9 model atmosphere files supplied.

* User-supplied name.

4.2 Sample Interactive Session

This section will feature an illustrative interactive session with the SHARC input module. The prompts from SHARC are capitalized. User responses are contained in braces, { }. Text which is inserted in to the session to clarify user responses will be contained in < >.

In the interactive execution mode SHARC looks for the "SHARC.INP" input file. This file contains the user-supplied input parameters for SHARC (several of these files are supplied on the SHARC computer tape and discussed in the test case section of this manual). If "SHARC.INP" is not found, the input module will use a set of default values for all input parameters. Once SHARC has a set of input parameters, the input module displays the top-level input menu and the user can begin to set-up a new SHARC calculation. In this example, the initial default version of 'SHARC.INP' is listed in Table 11. After the user exits the interactive input module an new version of "SHARC.INP" is saved, this file is reproduced in Table 12.

Begin session:

{run SHARC}

<The main routine successfully opens the input file >
<called SHARC.INP and the main menu is displayed. >

STRATEGIC HIGH-ALTITUDE RADIANCE CODE

```
REVIEW OR MODIFY INPUT PARAMETERS

 1. TITLE FOR CALCULATION*
 2. MODEL ATMOSPHERE
 3. NEMESIS CONTROL PARAMETERS
 4. MOLECULAR EMITTERS*
 5. SOLAR ZENITH ANGLE
 6. POPULATION FILE*
 7. LOS GEOMETRY*
 8. SPECTRAL INTERVAL AND RESOLUTION*
 9. OUTPUT DATA*
* OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
11. EXIT WITH NO UPDATE OF DEFAULT FILE

ENTER # OF ITEM TO BE CHANGED
0 TO CONTINUE SHARC EXECUTION
{1}

      <The user can enter a number from 1 to 9 to enter a          >
      <submenu on topics 1 through 9.  Or by entering a value      >
      <of 10 the user can exit the input menu and update the       >
      <"SHARC.INP" file for a batch calculation.  Entering         >
      <an 11 will exit the sharc calculation without changing      >
      <the "SHARC.INP" file (used to quit SHARC when many input    >
      <parameters have been incorrectly entered) and entering a    >
      <0 will allow SHARC to continue interactive execution.       >
      <In this session we will start by entering a new title for   >
      <the calculation.                                            >

      <When entering a submenu the current values of parameters    >
      <are displayed.  Then the user is given the                  >
      <opportunity to keep the current values and return to the    >
      <main menu, or change the parameter values.                  >

1.0 REVIEW OR MODIFY TITLE:

    TITLE =    OLD TEST CASE

INPUT : 0 TO KEEP CURRENT TITLE
        1 TO INPUT NEW TITLE
{1}

INPUT TITLE: (MAXIMUM OF 68 CHARACTERS)
{NEW TEST CASE}

      <After the new information has been entered, the submenu     >
      <will re-display the current information.                    >

1.0 REVIEW OR MODIFY TITLE:
```

```
        TITLE =    NEW TEST CASE

    INPUT : 0 TO KEEP CURRENT TITLE
            1 TO INPUT NEW TITLE
{0}
            <Entering a 0 here will return the user to the top menu.    >

    REVIEW OR MODIFY INPUT PARAMETERS

    1. TITLE FOR CALCULATION*
    2. MODEL ATMOSPHERE
    3. NEMESIS CONTROL PARAMETERS
    4. MOLECULAR EMITTERS*
    5. SOLAR ZENITH ANGLE
    6. POPULATION FILE*
    7. LOS GEOMETRY*
    8. SPECTRAL INTERVAL AND RESOLUTION*
    9. OUTPUT DATA*
   * OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

   10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
   11. EXIT WITH NO UPDATE OF DEFAULT FILE

    ENTER # OF ITEM TO BE CHANGED
    0 TO CONTINUE SHARC EXECUTION
{4}

            <The submenus can be accessed in any order. For example,    >
            <the next item we will change in this session is the        >
            <molecular emitters.  Therefore the user enters a 4.        >

    4.0 REVIEW OR MODIFY ATMOSPHERIC RADIATORS...

     CURRENTLY THERE ARE  1 RADIATORS
     EACH MOLECULAR RADIATOR REQUIRES THREE INPUT DATA SETS

    AFGL#  MOLECULE   LINKING FILE   STATES FILE  BAND FILE
      1       H2O       H2OLINK.DAT   H2OSTAT.DAT  H2OBAND.DAT


      TO ADD SPECIES INPUT THE AFGL #
      TO REMOVE SPECIES INPUT THE NEGATIVE AFGL #
      PLEASE INPUT ONE CHANGE AT A TIME.
      TYPE 0 TO RETURN TO MAIN MENU
{5}
            <To add CO as radiator enter a 5.  The AFGL numbers for     >
            <the supported molecular radiators will be displayed if     >
            <an incorrect, or unsupported molecule is selected.         >
            <As discussed in Section 4.1 there are three files          >
            <required for each added molecular radiator.                >

    ADDING  CO AS RADIATOR
```

```
     INPUT LINKING FILE
{COLINK.DAT}
     INPUT STATES FILE
{COSTAT.DAT}
     INPUT BAND FILE
{COBAND.DAT}

           <Current values are re-displayed.                               >
      CURRENTLY THERE ARE  2 RADIATORS
      EACH MOLECULAR RADIATOR REQUIRES THREE INPUT DATA SETS

     AFGL#  MOLECULE   LINKING FILE   STATES FILE  BAND FILE
       1      H2O       H2OLINK.DAT   H2OSTAT.DAT  H2OBAND.DAT
       5      CO        COLINK.DAT    COSTAT.DAT   COBAND.DAT

       TO ADD SPECIES INPUT THE AFGL #
       TO REMOVE SPECIES INPUT THE NEGATIVE AFGL #
       PLEASE INPUT ONE CHANGE AT A TIME.
       TYPE 0 TO RETURN TO MAIN MENU
{0}
           <Return to main menu.                                           >

     REVIEW OR MODIFY INPUT PARAMETERS

     1. TITLE FOR CALCULATION*
     2. MODEL ATMOSPHERE
     3. NEMESIS CONTROL PARAMETERS
     4. MOLECULAR EMITTERS*
     5. SOLAR ZENITH ANGLE
     6. POPULATION FILE*
     7. LOS GEOMETRY*
     8. SPECTRAL INTERVAL AND RESOLUTION*
     9. OUTPUT DATA*
    * OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

    10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
    11. EXIT WITH NO UPDATE OF DEFAULT FILE

     ENTER # OF ITEM TO BE CHANGED
     0 TO CONTINUE SHARC EXECUTION
{2}
           <Enter a 2 to review and/or change the model atmosphere.        >

     2.0 REVIEW OR MODIFY INPUT MODEL ATMOSPHERE...

        CURRENT VALUES ARE:
     1. ATMOSPHERE #2 CALLED SAT15AN.DAT
     2. EXO-ATMOSPHERIC TEMPERATURE (K):  1000.0
     3. NIGHT OR DAYTIME:  NIGHT

     ENTER # OF ITEM TO BE CHANGED
     0 TO CONTINUE
```

```
{1}
          <We wish to change to the 1976 standard atmosphere model     >
          <provided with SHARC.                                        >

     POSSIBLE ATMOSPHERES :
     1.  1976 STANDARD
     2.  15 DEG. ANNUAL
     3.  30 DEG. SUMMER
     4.  30 DEG. WINTER
     5.  45 DEG. SPRING/FALL
     6.  45 DEG. SUMMER
     7.  45 DEG. WINTER
     8.  60 DEG. SUMMER
     9.  60 DEG. WINTER
    10.  USER DEFINED ATMOSPHERE
     SELECT ATMOSPHERE :
{1}

        CURRENT VALUES ARE:
     1. ATMOSPHERE #1 CALLED SAT1976.DAT
     2. EXO-ATMOSPHERIC TEMPERATURE (K):  1000.0
     3. NIGHT OR DAYTIME:  NIGHT

     ENTER # OF ITEM TO BE CHANGED
     0 TO CONTINUE
{0}
          <The other two parameters are already what we want, so we    >
          <return to the main menu.                                    >

     REVIEW OR MODIFY INPUT PARAMETERS

     1. TITLE FOR CALCULATION*
     2. MODEL ATMOSPHERE
     3. NEMESIS CONTROL PARAMETERS
     4. MOLECULAR EMITTERS*
     5. SOLAR ZENITH ANGLE
     6. POPULATION FILE*
     7. LOS GEOMETRY*
     8. SPECTRAL INTERVAL AND RESOLUTION*
     9. OUTPUT DATA*
    * OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

    10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
    11. EXIT WITH NO UPDATE OF DEFAULT FILE

     ENTER # OF ITEM TO BE CHANGED
     0 TO CONTINUE SHARC EXECUTION
{3}
          <Next we wish to review the NEMESIS parameters to insure     >
          <that the sunlight is turned off and that earthshine is      >
          <turned on.  We entered a 3.                                 >
```

```
3.0 REVIEW OR MODIFY NEMESIS INPUTS...

   CURRENT VALUES ARE:
1. NUMBER OF TRIAL PHOTONS :          10000
2. MAXIMUM ORDER OF SCATTERING :        100
3. SUNLIGHT (0=NO , 1=YES) :              0
4. EARTHSHINE (0=NO , 1=YES) :            0
ENTER # OF ITEM TO BE CHANGED
0 TO CONTINUE
```

{4}

```
      <Sunlight is turned off, which is correct for our new      >
      <nighttime run.  Earthshine is also currently turned off,  >
      <so we will turn on earthshine.                            >

DO YOU WANT EARTHSHINE ?
INPUT 1 FOR YES, OR 0 FOR NO
```

{1}

```
   CURRENT VALUES ARE:
1. NUMBER OF TRIAL PHOTONS :          10000
2. MAXIMUM ORDER OF SCATTERING :        100
3. SUNLIGHT (0=NO , 1=YES) :              0
4. EARTHSHINE (0=NO , 1=YES) :            1

ENTER # OF ITEM TO BE CHANGED
0 TO CONTINUE
```

{0}

```
      <Return to main menu.                                      >

REVIEW OR MODIFY INPUT PARAMETERS

1. TITLE FOR CALCULATION*
2. MODEL ATMOSPHERE
3. NEMESIS CONTROL PARAMETERS
4. MOLECULAR EMITTERS*
5. SOLAR ZENITH ANGLE
6. POPULATION FILE*
7. LOS GEOMETRY*
8. SPECTRAL INTERVAL AND RESOLUTION*
9. OUTPUT DATA*
* OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
11. EXIT WITH NO UPDATE OF DEFAULT FILE

ENTER # OF ITEM TO BE CHANGED
0 TO CONTINUE SHARC EXECUTION
```

{6}

```
      <This calculation will be the first in a series of         >
      <calculations based on the same atmosphere.  Therefore,    >
      <the user wants to save the population information to     >
      <reuse in future calculations.                             >
```

```
          <To do this the user selects submenu number 6.                >

     6.0 REVIEW OR MODIFY POPULATION FILE NAME:

         CURRENT VALUES ARE:
      1. POPULATION FILE NAME IS = OLDPOP.DAT
      2. POPULATION FILE STATUS = OLD FILE
     INPUT : 0 TO KEEP CURRENT NAME AND STATUS
             1 TO INPUT NEW NAME
             2 TO CHANGE STATUS OF FILE
{1}

     INPUT NAME: (MAXIMUM OF 20 CHARACTERS)
{NEWPOP.DAT}

         CURRENT VALUES ARE:
      1. POPULATION FILE NAME IS = NEWPOP.DAT
      2. POPULATION FILE STATUS = OLD FILE

     INPUT : 0 TO KEEP CURRENT NAME AND STATUS
             1 TO INPUT NEW NAME
             2 TO CHANGE STATUS OF FILE
{2}

     INPUT STATUS OF FILE (0=NEW) OR (1=OLD)
{0}

         CURRENT VALUES ARE:
      1. POPULATION FILE NAME IS = NEWPOP.DAT
      2. POPULATION FILE STATUS = NEW FILE

     INPUT : 0 TO KEEP CURRENT NAME AND STATUS
             1 TO INPUT NEW NAME
             2 TO CHANGE STATUS OF FILE
{0}
          <Return to main menu.                                          >

     REVIEW OR MODIFY INPUT PARAMETERS

     1. TITLE FOR CALCULATION*
     2. MODEL ATMOSPHERE
     3. NEMESIS CONTROL PARAMETERS
     4. MOLECULAR EMITTERS*
     5. SOLAR ZENITH ANGLE
     6. POPULATION FILE*
     7. LOS GEOMETRY*
     8. SPECTRAL INTERVAL AND RESOLUTION*
     9. OUTPUT DATA*
    * OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

    10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
```

```
    11. EXIT WITH NO UPDATE OF DEFAULT FILE

     ENTER # OF ITEM TO BE CHANGED
     0 TO CONTINUE SHARC EXECUTION
{7}

           <Now to change the LOS geometry to a limb viewing geometry  >
           <with a 120 km tangent height.                              >

     7.0 REVIEW OR MODIFY LINE-OF-SIGHT GEOMETRY...

     CURRENT VALUES ARE:

     TANGENT HEIGHT:   60 KM

     INPUT : 0 TO KEEP CURRENT LOS GEOMETRY
             1 TO CHANGE LOS GEOMETRY
{1}
           <As described in Section 4.4, there are three types of LOS  >
           <paths supported.  If the users selects a path type that    >
           <is not supported the submenu will prompt for a new path    >
           <type.                                                      >

     PATH TYPES:

     2 -- OBSERVER TO SOURCE POINT
     3 -- OBSERVER TO SPACE
     4 -- LIMB VIEWING PATH
     SELECT PATH TYPE (0 TO KEEP CURRENT INFORMATION) :
{5}

     PATH TYPE NOT SUPPORTED, TRY AGAIN

     PATH TYPES:

     2 -- OBSERVER TO SOURCE POINT
     3 -- OBSERVER TO SPACE
     4 -- LIMB VIEWING PATH
     SELECT PATH TYPE (0 TO KEEP CURRENT INFORMATION) :
{4}

     INPUT TANGENT HEIGHT IN KM
{120}
           <The user types in desired tangent height in kilometers.    >

     CURRENT VALUES ARE:

     TANGENT HEIGHT:   120 KM

     INPUT : 0 TO KEEP CURRENT LOS GEOMETRY
             1 TO CHANGE LOS GEOMETRY
{0}
```

```
        <Return to main menu.                                        >

   REVIEW OR MODIFY INPUT PARAMETERS

   1. TITLE FOR CALCULATION*
   2. MODEL ATMOSPHERE
   3. NEMESIS CONTROL PARAMETERS
   4. MOLECULAR EMITTERS*
   5. SOLAR ZENITH ANGLE
   6. POPULATION FILE*
   7. LOS GEOMETRY*
   8. SPECTRAL INTERVAL AND RESOLUTION*
   9. OUTPUT DATA*
  * OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

  10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
  11. EXIT WITH NO UPDATE OF DEFAULT FILE

   ENTER # OF ITEM TO BE CHANGED
   0 TO CONTINUE SHARC EXECUTION
{8}
        <This submenu will allow the user to change or modify the    >
        <spectral range and spectral resolution.  These parameters   >
        <are described in more detail in Section 4.4.3.              >

   8.0 REVIEW OR MODIFY SPECTRAL INPUTS...

      CURRENT VALUES ARE:
   1. MINIMUM WAVENUMBER :   250.0
   2. MAXIMUM WAVENUMBER :   1000.0
   3. SPECTRAL RESOLUTION (MINIMUM OF .1 1/cm) :  1.0
   4. RELAYERING OF ATMOSPHERE FOR OPTICALLY THIN LINES : 0
      1 FOR YES, 0 FOR NO

   ENTER # OF ITEM TO BE CHANGED
   0 TO CONTINUE
{2}

   INPUT MAXIMUM OF SPECTRAL INTERVAL IN WAVENUMBERS :
{2300}

      CURRENT VALUES ARE:
   1. MINIMUM WAVENUMBER :   250.0
   2. MAXIMUM WAVENUMBER :   2300.0
   3. SPECTRAL RESOLUTION (MINIMUM OF .1 1/cm) :  1.0
   4. RELAYERING OF ATMOSPHERE FOR OPTICALLY THIN LINES : 0
      1 FOR YES, 0 FOR NO

   ENTER # OF ITEM TO BE CHANGED
   0 TO CONTINUE
{0}
        <Return to main menu.                                        >
```

```
REVIEW OR MODIFY INPUT PARAMETERS

 1. TITLE FOR CALCULATION*
 2. MODEL ATMOSPHERE
 3. NEMESIS CONTROL PARAMETERS
 4. MOLECULAR EMITTERS*
 5. SOLAR ZENITH ANGLE
 6. POPULATION FILE*
 7. LOS GEOMETRY*
 8. SPECTRAL INTERVAL AND RESOLUTION*
 9. OUTPUT DATA*
* OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
11. EXIT WITH NO UPDATE OF DEFAULT FILE

 ENTER # OF ITEM TO BE CHANGED
 0 TO CONTINUE SHARC EXECUTION
{9}
        <There is a detailed discussion in Section 5.3 of the      >
        <possible output details obtained by selecting low and     >
        <high values for the above options.  Note some options     >
        <are not currently used.                                   >

 9.0 REVIEW OR MODIFY OUTPUT DESIRED...'

     IWRITE VALUES RANGE FROM 0 TO 2'
     LOW VALUES DECREASE THE AMOUNT OF OUTPUT'
     HIGH VALUES INCLUDE ALL OUTPUT FROM LOWER VALUES'
     FOR EXAMPLE: IWRITE=2 WOULD INCLUDE IWRITE=1 OUTPUT'

   CURRENT VALUES ARE:
 1. MODEL ATMOSPHERE OUTPUT:                 0
 2. ATMOSPHERIC MOLECULE IDENTIFICATION:     0
 3. MOLECULAR RADIATORS AND FILE NAMES:      0
 5. SELECTED TRANSITIONS:                    0
 6. MOLECULAR BAND INFORMATION:              0
 7. NEMESIS OUTPUT:                          0
 8. FINAL EXCITED STATE POPULATIONS:         0
 9. EXCITED STATE VIBRATIONAL TEMPERATURES:  0
10. LINE-OF-SIGHT OUTPUT:                    0
12. SPECTRAL RADIANCE OUTPUT:                0

 ENTER # OF ITEM TO BE CHANGED
 0 TO CONTINUE
        <In its current state very little output would be saved in >
        <this calculation.  To print out the model atmosphere one  >
        <would provide a new value for option 1.  Start by         >
        <selecting 1.                                              >

{1}
```

```
     MODEL ATMOSPHERE OUTPUT:'
     INPUT: 0 FOR ATMOSPHERE NAME ONLY'
     INPUT: 1 FOR NAME AND LISTING OF ATMOSPHERE'
{1}
           <Now the atmospheric profile will be saved in the general    >
           <output file.  All of the options have at least two levels   >
           <of available output detail.                                  >

        CURRENT VALUES ARE:
     1. MODEL ATMOSPHERE OUTPUT:                     1
     2. ATMOSPHERIC MOLECULE IDENTIFICATION:         0
     3. MOLECULAR RADIATORS AND FILE NAMES:          0
     5. SELECTED TRANSITIONS:                        0
     6. MOLECULAR BAND INFORMATION:                  0
     7. NEMESIS OUTPUT:                              0
     8. FINAL EXCITED STATE POPULATIONS:             0
     9. EXCITED STATE VIBRATIONAL TEMPERATURES:      0
    10. LINE-OF-SIGHT OUTPUT:                        0
    12. SPECTRAL RADIANCE OUTPUT:                    0

     ENTER # OF ITEM TO BE CHANGED
     0 TO CONTINUE
{9}

     EXCITED STATE VIBRATIONAL TEMPERATURES
     INPUT: 0 FOR NO OUTPUT
     INPUT: 1 FOR EXCITED STATE VIBRATIONAL TEMPERATURES
{1}
           <Now the vibrational temperatures for the excited state      >
           <species will be saved in the general output file.           >

        CURRENT VALUES ARE:
     1. MODEL ATMOSPHERE OUTPUT:                     1
     2. ATMOSPHERIC MOLECULE IDENTIFICATION:         0
     3. MOLECULAR RADIATORS AND FILE NAMES:          0
     5. SELECTED TRANSITIONS:                        0
     6. MOLECULAR BAND INFORMATION:                  0
     7. NEMESIS OUTPUT:                              0
     8. FINAL EXCITED STATE POPULATIONS:             0
     9. EXCITED STATE VIBRATIONAL TEMPERATURES:      1
    10. LINE-OF-SIGHT OUTPUT:                        0
    12. SPECTRAL RADIANCE OUTPUT:                    0

     ENTER # OF ITEM TO BE CHANGED
     0 TO CONTINUE
{0}
           <Return to main menu.                                         >

     REVIEW OR MODIFY INPUT PARAMETERS

     1. TITLE FOR CALCULATION*
     2. MODEL ATMOSPHERE
```

```
     3. NEMESIS CONTROL PARAMETERS
     4. MOLECULAR EMITTERS*
     5. SOLAR ZENITH ANGLE
     6. POPULATION FILE*
     7. LOS GEOMETRY*
     8. SPECTRAL INTERVAL AND RESOLUTION*
     9. OUTPUT DATA*
    * OPTIONS CAN BE CHANGED WHILE USING OLD POPULATION FILES

    10. UPDATE DEFAULT FILE AND EXIT FOR BATCH EXECUTION
    11. EXIT WITH NO UPDATE OF DEFAULT FILE

     ENTER # OF ITEM TO BE CHANGED
     0 TO CONTINUE SHARC EXECUTION
(10)

     SHARC READY FOR BATCH RUN

          <Session completed.  Now the user has prepared the new     >
          <SHARC.INP file shown in Table 12 for use in a batch or    >
          <background calculation.                                   >
```

TABLE 11. SAMPLE SHARC.INP FILE.

```
C0 FILE SHARC.INP
C0 THIS FILE HOLDS THE DEFAULT VALUES FOR SHARC
C0 THIS FILE IS UPDATED TO THE CURRENT VALUES OF THE PARAMETERS
C0 EACH TIME SHARC IS RUN.
C0
C1 THE FIRST LINE CONTAINS THE INTERACTIVE/BATCH OPTION
C1 IF IT EQUALS 1, SHARC WILL RUN INTERACTIVELY, ALLOWING
C1 THE USER TO UPDATE OPTIONS.  IF IT EQUALS 0, SHARC WILL
C1 RUN IN BATCH MODE.  THIS PARAMETER IS SET TO 1 AFTER A
C1 SUCCESSFUL SHARC RUN.
C1 FORMAT = I4
C1##
   1
C2 TITLE FOR CALCULATION   WILL APPEAR ON TOP OF GENERAL OUTPUT FILE
C2 FORMAT(1X,A68,I3)
C#################################################################### ###
 OLD TEST CASE                                                        13
C3 LINE 2 CONTAINS THE VARIABLE IATMOS.
C3 THIS VARIABLE IS USED TO SELECT THE DESIRED MODEL ATMOSPHERE AND
C3 THE ATMOSPHERIC FILE NAME.
C3 FORMAT = I4,2X,A11
C3##  ###########
   2  SAT15AN.DAT
C4 LINE 3 CONTAINS THE EXO-ATMOSPHERIC TEMPERATURE AND
```

```
C4 A CONTROL PARAMETER WHICH SELECTS EITHER THE DAY OR NIGHT
C4 OPTION FOR THE MODEL ATMOSPHERE.
C4 FORMAT = E12.5,2X,A5
C4 #####E+## #####
  .10000E+04  NIGHT
C5 NEMESIS CONTROL PARAMETERS
C5 WARNING: CHANGING THESE PARAMETERS WILL EFFECT THE ACCURACY
C5 OF THE MONTE CARLO SIMULATION.
C5 TOTAL NUMBER OF PHOTONS, MAXIMUM ORDER OF SCATTERING
C5 GLOBAL SUNSHINE AND EARTHSHINE PARAMETERS (1=YES , 0=NO)
C5 FORMAT=2X,6I,2X,6I,2x,I6,2X,I6
C5 #####  ######  ######  ######
   10000     200       0       0
C6 AFGL# FOR MOLECULE,LINKING FILE, STATE FILE, BAND FILE
C6 UP TO 5 RADIATORS H2O=1, CO2=2, O3=3, CO=5, NO=8
C6FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C6####  ###########  ###########  ###########
     1  H2OLINK.DAT  H2OSTAT.DAT  H2OBAND.DAT
C7 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C7####  ###########  ###########  ###########
     0
C8 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C8 ###  ###########  ###########  ###########
     0
C9 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C9 ###  ###########  ###########  ###########
     0
C10FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C10###  ###########  ###########  ###########
     0
C11 SOLAR ZENITH ANGLE IN DEGREES. 0 FOR THE SUN OVERHEAD
C11( 0.0 WHEN THE SUN IS OVERHEAD) THIS OPTION IS USED FOR DAYLIGHT ONLY
C11FORMAT = E12.5
C#.#####E+##
  .00000E+02
C12NEXT 6 LINES CONTAIN LOS GEOMETRY INFORMATION
C12LINE 12 CONTAINS IPATH AND ICASE
C12FORMAT = I4,2X,I4
C12#  ####
   4     3
C13LINE 13 CONTAINS H1ALT, H1LONG AND H1LAT
C13FORMAT = 3(E12.7,2X)
C13#####E+##  .#######E+##  .#######E+##
.6100000E+02  .4500000E+02  .4500000E+02
C14LINE 14 CONTAINS H2ALT, H2LONG AND H2LAT
C14FORMAT = 3(E12.7,2X)
C14#####E+##  .#######E+##  .#######E+##
.6100000E+02  .1000000E+02  .1000000E+02
C15LINE 15 CONTAINS RANGE,BETA,A0
C15FORMAT = 3(E13.8,1x)
C15######E+## .########E+## .########E+##
 .6000000E+02  .1200000E+03  .0000000E+00
```

```
C16LINE 16 CONTAINS BO,HMIN,LEN
C16FORMAT = 2(E13.8,1x),I4
C16#######E+## .#########E+## ####
 .9000000E+02  .6000000E+02    0
C17Line 17 CONTAINS TIME,IDAY,ICASES
C17TIME IS GMT TIME (0. TO 24.)
C17IDAY IS FROM 1 TO 366
C17THESE OPTIONS ARE NOT USED IN SHARC-1
C17FORMAT = E12.7,2X,2I4
C17######E+##  #### ###
.0000000E+00     6   1
C18SPECTRAL INFORMATION IN CM-1
C18 WMIN,WMAX,BINRES(RESOLUTION),IRELAY=1 FOR RELAYERING
C18FORMAT = 2X,3(E12.5,2X),I2,2X,E12.5
C18#.#####E+##  ##.#####E+##  ##.#####E+##  ##
    .25000E+03    .10000E+04    .10000E+01   0
C19 OUTPUT CONTROL PARAMETERS:
C19 1) MODEL ATMOSPHERE OUTPUT ==>1 FOR FULL LISTING
C19 2) ATMOSPHERIC MOLECULE IDENTIFICATION == >2 FOR TABLE
C19 3) MOLECULAR RADIATORS INFORMATION ==>2 FOR ECHO OF INPUTS
C19 4) NOT CURRENTLY USED
C19 5) SELECTED TRANSITIONS ==>1 FOR TRANSITIONS SELECTED
C19 6) MOLECULAR BAND INFORMATION ==>2 FOR ECHO OF BAND INFORMATION
C19 7) NEMESIS OUTPUT ==>1 NEMESIS ONLY ==2 FOR POST POPULATIONS
C19 8) FINAL STATE POPULATIONS ==>1 YES
C19 9) FINAL VIBRATIONAL TEMPERATURES ==>1 YES
C19 10)LOS OUTPUT ==>1 FOR COLUMN DENSITIES
C19 11)CURRENTLY NOT USED
C19 12)SPECTRAL RADIANCE OUTPUT ==>1 FOR RADIANCE OUTPUT IN GENERAL
C19    OUTPUT FILE  SPECTRAL INFORMATION IS ALWAYS PLACED IN SPEC.OUT
C19 FORMAT = 12(2X,I2)
C  1   2   3   4   5   6   7   8   9  10  11  12
C ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##
   0   0   0   0   0   0   0   0   0   0   0   0
C20 SAVED POPULATIONS FILE NAME AND ISAVE
C20 WHEN ISAVE = 0 POPULATIONS ARE SAVED
C20 ISAVE = 1 SAVED POPULATIONS ARE USED FOR CALCULATION
C20 FORMAT=(2X,A20,2X,I4)
C2######################  ####
  OLDPOP.DAT              1
```

TABLE 12. UPDATED SHARC.INP FILE.

```
CO FILE SHARC.INP
CO THIS FILE HOLDS THE DEFAULT VALUES FOR SHARC
CO THIS FILE IS UPDATED TO THE CURRENT VALUES OF THE PARAMETERS
CO EACH TIME SHARC IS RUN.
```

```
C0
C1 THE FIRST LINE CONTAINS THE INTERACTIVE/BATCH OPTION
C1 IF IT EQUALS 1, SHARC WILL RUN INTERACTIVELY, ALLOWING
C1 THE USER TO UPDATE OPTIONS.  IF IT EQUALS 0, SHARC WILL
C1 RUN IN BATCH MODE.  THIS PARAMETER IS SET TO 1 AFTER A
C1 SUCCESSFUL SHARC RUN.
C1 FORMAT = I4
C1##
   0
C2 TITLE FOR CALCULATION   WILL APPEAR ON TOP OF GENERAL OUTPUT FILE
C2 FORMAT(1X,A68,I3)
C#################################################################### ###
 NEW TEST CASE                                                          13
C3 LINE 2 CONTAINS THE VARIABLE IATMOS.
C3 THIS VARIABLE IS USED TO SELECT THE DESIRED MODEL ATMOSPHERE AND
C3 THE ATMOSPHERIC FILE NAME.
C3 FORMAT = I4,2X,A11
C3##  ###########
   1  SAT1976.DAT
C4 LINE 3 CONTAINS THE EXO-ATMOSPHERIC TEMPERATURE AND
C4 A CONTROL PARAMETER WHICH SELECTS EITHER THE DAY OR NIGHT
C4 OPTION FOR THE MODEL ATMOSPHERE.
C4 FORMAT = E12.5,2X,A5
C4 #####E+##  #####
  .10000E+04  NIGHT
C5 NEMESIS CONTROL PARAMETERS
C5 WARNING: CHANGING THESE PARAMETERS WILL EFFECT THE ACCURACY
C5 OF THE MONTE CARLO SIMULATION.
C5 TOTAL NUMBER OF PHOTONS, MAXIMUM ORDER OF SCATTERING
C5 GLOBAL SUNSHINE AND EARTHSHINE PARAMETERS (1=YES , 0=NO)
C5 FORMAT=2X,6I,2X,6I,2x,I6,2X,I6
C5 #####  ######  ######  ######
   10000     200       0      1
C6 AFGL# FOR MOLECULE,LINKING FILE, STATE FILE, BAND FILE
C6 UP TO 5 RADIATORS H2O=1, CO2=2, O3=3, CO=5, NO=8
C6FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C6####  ###########  ###########  ###########
     1  H2OLINK.DAT  H2OSTAT.DAT  H2OBAND.DAT
C7 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C7####  ###########  ###########  ###########
     5  COLINK.DAT   COSTAT.DAT   COBAND.DAT
C8 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C8 ###  ###########  ###########  ###########
     0
C9 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C9 ###  ###########  ###########  ###########
     0
C10FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C10###  ###########  ###########  ###########
     0
C11 SOLAR ZENITH ANGLE IN DEGREES. 0 FOR THE SUN OVERHEAD
C11( 0.0 WHEN THE SUN IS OVERHEAD) THIS OPTION IS USED FOR DAYLIGHT ONLY
```

```
C11FORMAT = E12.5
C#.#####E+##
  .00000E+02
C12NEXT 6 LINES CONTAIN LOS GEOMETRY INFORMATION
C12LINE 12 CONTAINS IPATH AND ICASE
C12FORMAT = I4,2X,I4
C12#  ####
   4     3
C13LINE 13 CONTAINS H1ALT, H1LONG AND H1LAT
C13FORMAT = 3(E12.7,2X)
C13######E+##  .#######E+##  .#######E+##
.6100000E+02  .4500000E+02  .4500000E+02
C14LINE 14 CONTAINS H2ALT, H2LONG AND H2LAT
C14FORMAT = 3(E12.7,2X)
C14######E+##  .#######E+##  .#######E+##
.6100000E+02  .1000000E+02  .1000000E+02
C15LINE 15 CONTAINS RANGE,BETA,A0
C15FORMAT = 3(E13.8,1x)
C15#######E+## .########E+## .########E+##
 .6000000E+02  .1200000E+03  .0000000E+00
C16LINE 16 CONTAINS B0,HMIN,LEN
C16FORMAT = 2(E13.8,1x),I4
C16#######E+## .########E+## ####
 .9000000E+02  .1200000E+03    0
C17Line 17 CONTAINS TIME,IDAY,ICASES
C17TIME IS GMT TIME (0. TO 24.)
C17IDAY IS FROM 1 TO 366
C17THESE OPTIONS ARE NOT USED IN SHARC-1
C17FORMAT = E12.7,2X,2I4
C17######E+##  #### ###
.0000000E+00     6   1
C18SPECTRAL INFORMATION IN CM-1
C18 WMIN,WMAX,BINRES(RESOLUTION),IRELAY=1 FOR RELAYERING
C18FORMAT = 2X,3(E12.5,2X),I2,2X,E12.5
C18#.#####E+##  ##.#####E+##  ##.#####E+##  ##
    .25000E+03    .23000E+04    .10000E+01   0
C19 OUTPUT CONTROL PARAMETERS:
C19 1) MODEL ATMOSPHERE OUTPUT ==>1 FOR FULL LISTING
C19 2) ATMOSPHERIC MOLECULE IDENTIFICATION == >2 FOR TABLE
C19 3) MOLECULAR RADIATORS INFORMATION ==>2 FOR ECHO OF INPUTS
C19 4) NOT CURRENTLY USED
C19 5) SELECTED TRANSITIONS ==>1 FOR TRANSITIONS SELECTED
C19 6) MOLECULAR BAND INFORMATION ==>2 FOR ECHO OF BAND INFORMATION
C19 7) NEMESIS OUTPUT ==>1 NEMESIS ONLY ==2 FOR POST POPULATIONS
C19 8) FINAL STATE POPULATIONS ==>1 YES
C19 9) FINAL VIBRATIONAL TEMPERATURES ==>1 YES
C19 10)LOS OUTPUT ==>1 FOR COLUMN DENSITIES
C19 11)CURRENTLY NOT USED
C19 12)SPECTRAL RADIANCE OUTPUT ==>1 FOR RADIANCE OUTPUT IN GENERAL
C19    OUTPUT FILE  SPECTRAL INFORMATION IS ALWAYS PLACED IN SPEC.OUT
C19 FORMAT = 12(2X,I2)
C  1   2   3   4   5   6   7   8   9  10  11  12
```

```
C ## ## ## ## ## ## ## ## ## ## ## ##
   1  0  0  0  0  0  0  0  1  0  0  0
C20 SAVED POPULATIONS FILE NAME AND ISAVE
C20 WHEN ISAVE = 0 POPULATIONS ARE SAVED
C20 ISAVE = 1 SAVED POPULATIONS ARE USED FOR CALCULATION
C20 FORMAT=(2X,A20,2X,I4)
C2####################  ####
  NEWPOP.DAT                0
```

4.3 Definition of Input Variables

The input parameters are read from the input file called SHARC.INP and are stored internally in a character*72 array called DFLTS. These parameters may be changed in SHARC.INP by editing the file directly, or by using the interactive input module. Parameters in SHARC.INP are written and read with fixed FORMAT. The required FORMATS and other comments are listed above the input data in SHARC.INP. Two example SHARC.INP files are shown in the previous section in Tables 10 and 11. There are 20 lines of actual input data in SHARC.INP. The input parameters on these lines are shown below.

LINE 1: Interactive/Batch — Format:I4

ACTIVE = 0 Skip interactive module
1 Run interactively

Note: ACTIVE is set to 1 after a successful SHARC run.

LINE 2: Title Card — Format:1X,A68,I3

TITLE — Title for this run

NTIT — Number of characters in TITLE

LINE 3: Atmospheric Model — Format:I4,2X,A11

IATMOS — Atmosphere number

ATNAME — Name of model atmosphere

LINE 4: Atmospheric Parameters — Format:E12.5,2x,A5

EXOTMP		Exo-atmospheric temperature
NGHTDY	NIGHT	Nighttime
	DAY	Daytime

LINE 5: NEMESIS Parameters — Format:2X,I6,2X,I6,2X,I6,2X,I6

NPHOT		Total number of photons
NORDER		Maximum order of scattering
ISUN	= 0	No incident sunshine
	1	Include solar pumping
IEARTH	= 0	No upwelling earthshine
	1	Include earthshine pumping

Warning: Changing these parameters affects the accuracy of the Monte Carlo simulation. The Nemesis parameters are discussed in Section 4.4.1

LINE 6-10: Molecular Radiators — Format:2X,I4,2X,11A1,2X,11A1,2X,11A1

IRAD	= 0	No radiator
	1	H_2O
	2	CO_2
	3	O_3
	5	CO
	8	NO

Note: These follow the HITRAN identification numbers.

MOLNAM(1)	Name of linking file, e.g., O3LINK.DAT (IRAD=3)
MOLNAM(2)	Name of state file, e.g., O3STAT.DAT (IRAD=3)
MOLNAM(3)	Name of band file, e.g., O3BAND.DAT (IRAD=3)

LINE 11: Solar Direction — Format:E12.5

SOLANG(deg)	Solar zenith angle

LINE 12: Observer Path — Format:I4,2X,I4

IPATH	=2	Observer to specified point
	3	Observer to space
	4	Limb viewing from space

ICASE		Determines LOS input parameter sequences NOTE: The geometry parameters are discussed in greater detail in Section 4.4.2

LINE 13: Observer Parameters Format:3(E12.7,2X)

H1ALT (km)		Observer altitude
H1LONG(deg)		" longitude
H1LAT (deg)		" latitude

LINE 14: Source Parameters Format:3(E12.7,2X)

H2ALT (km)		Source (or target) altitude
H2LONG(deg)		" longitude
H2LAT (deg)		" latitude

LINE 15: Other Path Parameters Format:3(E13.8,1X)

RANGE (km)		Range
BETA (deg)		Earth center angle subtended by path
A0 (deg)		Path zenith angle at observer

LINE 16: Other Path Parameters Format:3(E13.8,1X)

BO (deg)		Path azimuthal angle
HMIN (km)		Minimum altitude for limb path
LEN	= 0	Short downward limb path
	1	Long " " "

LINE 17: Additional Parameters Format:E12.7,2X,I4

NOTE: These parameters are not used in this version of SHARC

TIME		Greenwich Mean Time
IDAY		Day of the year (1 to 366)
ICASES		Determines solar input parameter sequences

LINE 18: Spectral Parameters Format:2X,3(E12.5,2X),I2,2X,E12.5

WMIN (cm^{-1})		Minimum Wavenumber for Calculation
WMAX (cm^{-1})		Maximum Wavenumber for Calculation
BINRES(cm^{-1})		Resolution
IRELAY	=0	No Relayering
	1	Relayer atmosphere for radiance calculation of optically thin lines. This option is detailed in Section 4.4.3

LINE 19: Output Parameters Format:12(2X,I2)

IWRITE(1-12)	=0	Minimal output
	1	Recommended output
	2	Debugging output
		NOTE: Section 5.2 details the output options which can be selected for the 12 IWRITE's

LINE 20: Population File Format:2X,A20,2X,I4

POPNAM		Name of population file
ISAVE	=0	POPNAM is new file
	1	POPNAM is old file

4.4 Detailed Parameter Discussion

This section defines the input parameters for the NEMESIS, GEOMETRY, and SPCRAD modules. The NEMESIS control parameters warrant further description since the accuracy of the Monte Carlo simulation depends upon their values. The Geometry parameters section will describe the various subsets of geometry variables needed to define a LOS. The relayering option is discussed in the SPCRAD parameter section.

4.4.1 NEMESIS Parameters

The NEMESIS module determines the enhancement of the atmospheric excited states layer populations due to layer radiative self-trapping and layer-layer radiative pumping. The module determines the first-order population enhancement using a Monte Carlo simulation of the initial source photon

emission and absorption or escape. The number of photons, NPHOT, determines the statistical uncertainty of the Monte Carlo calculation. Changing this variable to a small number saves computer time, but causes large statistical uncertainties. For reasonable statistical uncertainties NPHOT should be 10,000 or larger.

The NORDER parameter determines the maximum order of scattering calculated by NEMESIS. Changing this number to less than 100 does not save much computer time since the Monte Carlo simulation is performed for first-order scattering only and higher order scattering is determined recursively. Many orders of scattering may be important for some molecular bands, such as 4.3 μm CO_2 radiation. A value of 100 for NORDER is sufficiently large.

The ISUN and IEARTH parameters turn on/off solar and earthshine pumping. A value of 1 means the pumping is on and a value of 0 means the pumping is off.

4.4.2 Geometry Parameters

The LOS is defined as the straight line which connects the observer located at a point H1 to the source located at H2. Curvature of the LOS due to refraction is negligible over the altitude regime considered in SHARC. Three classes of LOS paths are supported by SHARC and are specified through the variable IPATH:

```
IPATH = 2  --  observer to  source,
      = 3  --  observer to space, and
      = 4  --  limb viewing.
```

The nomenclature used in the geometry module is derived from the low-altitude radiance code LOWTRAN 6.[7] In the current SHARC version, there is no IPATH = 1 option. There are a number of geometric parameters that must be specified in order to define each type of path, and these are defined in Table 13 and illustrated in Figure 3. Altitudes and ranges are given in km, and angles in degrees. Longitudes can have values ranging form 0^{o} to 360^{o}, and latitudes, from -90^{o} at the south pole to 90^{o} at the north pole. A0 is the local zenith angle of the LOS as measured from the vertical line connecting H1 and the

earth center. The angle BO is the azimuth of the LOS as measured in the plane normal to the vertical at the same altitude as the observer (e.g., the local horizontal); it varies from -180° to 180°.

TABLE 13. LOS PARAMETERS.

H1ALT	observer altitude
H1LONG	" longitude
H1LAT	" latitude
H2ALT	source altitude
H2LONG	" longitude
H2LAT	" latitude
RANGE	distance from H1 to H2
BETA	earth-center angle between H1 and H2
AO	zenith angle of LOS at observer
BO	LOS azimuthal angle; north = 0 & east = 90°
HMIN	tangent height from the surface of the earth;
LEN	designates short or long paths for certain down-looking geometries

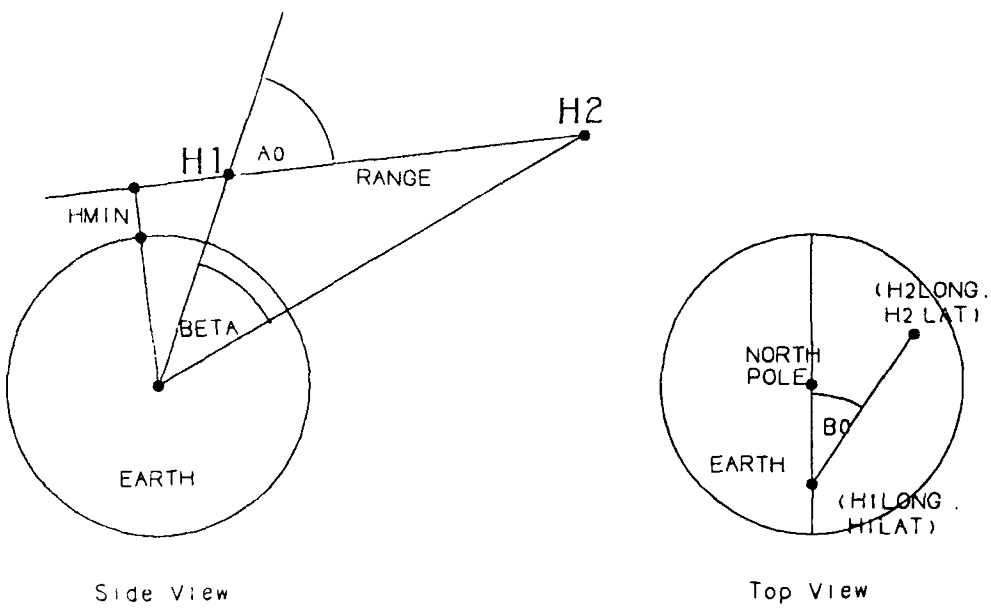

Figure 3. Definitions of LOS Parameters.

The parameters listed in Table 13 overspecify the LOS. For a particular LOS only one of many different subsets is required as input. The other parameters are calculated internally. Each class, designated by its IPATH value, has various options for specifying the LOS. These are labeled by the integer variable ICASE and are listed in Table 14 along with the required geometrical inputs. The particular case with IPATH = 2 and ICASE = 1 is ambiguous when H1 > H2. The two paths are distinguished with the LEN variable and are illustrated in Figure 4.

TABLE 14. GEOMETRY INPUT SEQUENCES.

IPATH	ICASE	Geometrical Inputs
2	1	H1, H2ALT, A0, B0
		H1, H2ALT, A0, B0, LEN
	2	H1, RANGE, A0, B0
	3	H1, H2ALT, RANGE, B0
	4	H1, H2ALT, BETA, B0
	5	H1, H2ALT, H2LONG, H2LAT
3	1	H1, A0, B0
	2	H1, HMIN, B0
4	1	HMIN

Note: 1. H1 stands for (H1ALT, H1LAT, H1LONG).

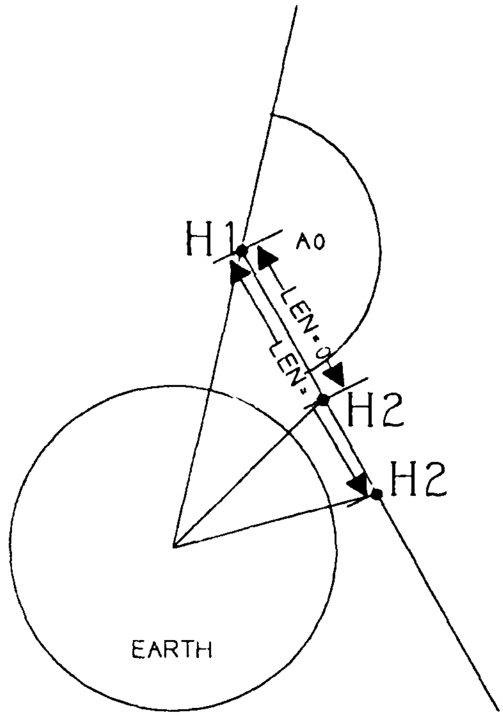

Figure 4. Specification of the LEN Parameter for Down-Looking Paths.

4.4.3 Spectral Radiance Parameters

The spectral range is defined by inputting the minimum, WMIN, and maximum, WMAX, frequency (cm^{-1}) of interest. SHARC currently includes lines from 250 to 5000 cm^{-1}. The spectral resolution, BINRES, is given in cm^{-1} and is currently limited to 0.1 cm^{-1}. The spectral radiance array can contain 10,000 points. So, if a 0.1 resolution is used only a 1000 cm^{-1} spectral range can be used. The interactive input module will alert the user if the range is too large for the selected resolution, and it will reset WMAX to reduce the range.

The relayering option allows users to save computational time by relayering the model atmosphere for optically thin transitions. The relayering takes adjacent atmospheric layers and combines them into a single larger layer. Care is taken to preserve the total column density and other properties, such as rotational and translational temperatures, are averaged over the combined layers. The SPCRAD module implements the relayering option

on a line-by-line basis. A total optical depth estimate is performed and if a line is found to be optically thin and the user has selected relayering, i.e. IRELAY=1, a relayered atmosphere is used. The relayering algorithm reduces n layers to $\sqrt{n}$ layers. Up to an order of magnitude increase in speed can be attained with little loss in accuracy. The total number of lines and the total number of relayered lines are summarized for each band in the general SHARC output file.

5. SHARC OUTPUT FILES

5.1 Error File

The SHARC error file (SHARC.ERR) contains error and warning statements generated during SHARC execution. The majority of error messages are due to improper preparation of the input files. Warning or caution messages usually result from inconsistent use of input files. An error message during execution is considered fatal, and execution will stop after the error message is written to the error file. A warning or caution message is not fatal (i.e., does not terminate execution), but it should inform the user that input files are inconsistent, that only a partial calculation has been performed, or that numerical difficulties have been encountered and fixed in one of the SHARC modules. The user should monitor the error file after each SHARC run to insure that the desired calculation was properly performed.

There are currently 113 different error/caution messages which can be written to the error file during execution. The error/caution messages contain the subroutine name in which the problem occurred. As an example of an error message, consider an error resulting from inconsistent input in the molecular states (see Section 3.2) and bands (see Section 3.3) files. Assume that the 2→1 vibrational transition for CO has been specified in the molecular states file (see Table 5). If the data for the line strength distribution function for the 2→1 transition has not been included in the molecular bands file (see Table 6), the following error message will be written to the error file:

```
ERROR IN BANDIN...
     CO(1)      - CO(0)      BAND MISSING FROM BAND DATA
```

prompting the user to check the CO bands file for an input error or omission of data.

As seen in the previous example, the error/caution messages generated from input files are usually self-explanatory, and the user should be able to easily correct the problem. In some cases, however, the problem may be more subtle. For example, error/caution messages generated during calculation of

number densities of vibrationally excited states most likely will require the user to carefully check the chemical kinetics mechanism and the list of transitions considered by NEMESIS.

5.2 General Output File

The general SHARC output file contains a summary of selected output from each module. As mentioned previously, there are three levels of output which can be obtained from each SHARC module. The level (and size) of output is selected through the interactive menu (see Section 4.2). The level of output can be selected independently for several of the SHARC modules. The lowest level contains the minimum amount of information (IWRITE=0) necessary to characterize the calculation, and the highest level contains the maximum amount of information (IWRITE=2). The type of output which is written to the output file for the specified IWRITE option is illustrated in Table 15. Notice that the atmosphere name and the band radiance summary (see Table 15) are always written to the output file, and the spectral radiance as a function of frequency is always written to the plot file (see Section 5.4).

TABLE 15. TYPE OF OUTPUT CONTAINED IN SHARC.OUT FILE.

OUTPUT	OPTION	DESCRIPTION
Model Atmosphere	0	Atmosphere File Name
	1,2	Complete Atmosphere Input File
Atmospheric Molecule ID	0,1	No Output
	2	AFGL Molecular Identification Number for Each Atmospheric Species
Molecular Radiators and File Names	0,1	No Output
	2	List of Selected Molecular Radiators, and Associated File Names for the "Linking", "States", and "Bands" Files
Selected Transitions	0	No Output
	1,2	Complete Molecular States Input File
Molecular Band Data	0,1	No Output
	2	Complete Molecular Bands Input File
NEMESIS Output	0	No Output
	1	Initial Steady State Layer Source Populations and NEMESIS Excited State Population Enhancements; Earthshine, Sunshine, and Atmospheric Excitation Rates; and the quenching/re-emission Probabilities
	2	Post NEMESIS Excited State Populations for Each Selected Transition
Final Excited State Populations	0	No Output
	1,2	Final Excited State Populations
Final Excited State Temperatures	0	No Output
	1,2	Final Excited State Temperatures
Line of Sight Output	0	
	1,2	Species Total Column Densities Along Line of Sight
Band Radiance Summary	-	The Transition, Frequency, Number of Lines for the Transition, and the Band Radiance for the Transition for Each Selected Radiator
Spectral Radiance Output	0	Plot File (SHARC.SPC)
	1,2	Spectral Radiance Table

5.3 Population File

The excited-state populations for each atmospheric layer will change only when a new model atmosphere is used, day and night conditions change or a new solar zenith angle is defined. Thus, the excited-state populations and the information necessary to uniquely characterize them are written to a binary "population" file. This allows the user to perform multiple SHARC calculations for any number of observer-source scenarios without re-calculating the populations each time. The relevant information written to the "population" file is:

- Date of the excited state population calculation,
- The model atmosphere file (Section 3.5),
- The molecular radiators and the associated "linking", "states", and "bands" files,
- The list of species (Section 3.1) for each molecular radiator,
- The molecular states file (Section 3.2) for each molecular radiator, and
- The excited state populations and associated temperatures for each molecular radiator.

For subsequent calculations using the "population" file, it is necessary to change only the input and output parameters relevant to the GEOMETRY and/or SPCRAD sections of the SHARC.INP file (Section 4.2-4.3). Although the complete set of options described in Section 5.2 for creating the general output file are not available when using a previously created "population" file, the output file does contains sufficient detail to uniquely characterize the "population" file used. However, the user should refer back to the original general output file generated when the population file was created if any greater detail is desired.

5.4 Plot File

An ASCII plot file (SHARC.SPC) is created to allow the user to either plot the calculated spectral radiance directly or to further reduce the data.

For example, the user may wish to apply a specific filter function to the spectral radiance or to convert to a set of units other than those used by SHARC. The plot file contains the frequency (cm^{-1}) and the spectral radiance ($W/sr/cm^2/cm^{-1}$) written as an (x,y) ordered pair with one pair per line.

6. RUNNING THE PLOTTING PACKAGE

The plotting software is a separate package which can be used to plot the SHARC spectral output. The plotting program, which is a general x-y plotting package, is interactive and has two menus of options. First, the program queries the user for the input file name that is to be read and plotted. The default name for the file is SPEC.OUT. This is the name of the spectral output file generated by the SHARC program. The input file is a unformatted list of x,y pairs without any header information. After the input file is read the menu options can be modified for a particular plotting case. The first menu has eight options which can be altered. These include the plot output file name, the titles for the plot and the x and y axes, the plot type, the location of the axis tic marks, and the lengths of the x and y axes. A set of standard default values of these parameters is presented to the user. These default values can be changed or the next menu can be accessed by typing a zero. The second menu allows the dynamic range of the radiance (y axis) and the wavenumber interval (x axis) to be adjusted. Default values are calculated from the input data file which span the entire dynamic range of the radiance and the entire wavenumber interval of the input. Adjustment of the number of major and minor tics on the axis is also an option of the second menu. A session with the plot package is included here to illustrate the interactive nature of the program. User responses are contained in brackets {..} to distinguish them from the program queries. Comments about the program queries and user responses are contained in the brackets <..>.

Begin session:

{run plot}

<An interactive session for plotting a SHARC output spectrum.>

....

THE DEFAULT FILE NAME IS SPEC.OUT
IS THIS THE FILE YOU WANT PLOTTED? [Y,N]

{N}

<Responding with a "n" causes the program to request an >
<input file. >

```
     INPUT THE FILE NAME FOR THE DATA TO BE PLOTTED
{NOSPEC.OUT}
           <The program will now read in data from the disk file      >
           <file NOSPEC.OUT.                                          >

           <The first menu will now be printed on the screen.  Each   >
           <time it is presented it contains the current options.     >
           <Initially it contains default options.  When the          >
           <user is satisfied with the options, a "0" response        >
           <will cause the program to go to the next menu.            >

     THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
     1. Plot output file :OUTPUT.PLT
     2. Plot title       :SHARC SPECTRUM
     3. X-axis label     :WAVENUMBER
     4. Y-axis label     :RADIANCE
     5. Plot type        :SEMI-LOG PLOT (X LINEAR)
     6. Tic marks        :OUTSIDE GRAPH
     7. X-axis length in inches: 5.0
     8. Y-axis length in inches: 5.0

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{1}
           <Responding with a "1" causes the program to request a     >
           <new file name for the plot data.                          >


     INPUT THE NAME OF THE PLOT OUTPUT FILE
{NO.PLT}
           <The output plot data will be in file NO.PLT.              >


     THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
     1. Plot output file :NO.PLT
     2. Plot title       :SHARC SPECTRUM
     3. X-axis label     :WAVENUMBER
     4. Y-axis label     :RADIANCE
     5. Plot type        :SEMI-LOG PLOT (X LINEAR)
     6. Tic marks        :OUTSIDE GRAPH
     7. X-axis length in inches: 5.0
     8. Y-axis length in inches: 5.0

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{2}
           <Responding with a "2" causes the program to request a new >
           <title for the plot.                                       >

     INPUT THE PLOT TITLE
{NO 60 km limb}
           <The plot title will now be "NO 60 km limb"                >

     THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
```

```
     1. Plot output file :NO.PLT
     2. Plot title       :NO 60 km limb
     3. X-axis label     :WAVENUMBER
     4. Y-axis label     :RADIANCE
     5. Plot type        :SEMI-LOG PLOT (X LINEAR)
     6. Tic marks        :OUTSIDE GRAPH
     7. X-axis length in inches: 5.0
     8. Y-axis length in inches: 5.0

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{3}
           <Responding with a "3" causes the program to request a new  >
           <label for the x axis.                                       >

     INPUT THE X-AXIS LABEL
{wavenumber (cm^-^1)}
           <The label will now be in lower case and contain units.     >


     THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
     1. Plot output file :NO.PLT
     2. Plot title       :NO 60 km limb
     3. X-axis label     :wavenumber (cm^-^1)
     4. Y-axis label     :RADIANCE
     5. Plot type        :SEMI-LOG PLOT (X LINEAR)
     6. Tic marks        :OUTSIDE GRAPH
     7. X-axis length in inches: 5.0
     8. Y-axis length in inches: 5.0

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{4}
           <Responding with a "4" causes the program to request a new  >
           <label for the y axis.                                       >

     INPUT THE Y-AXIS LABEL
{Spectral Radiance (W/sr/cm^2/cm^-^1}
           <The label will now be contain units.                        >

     THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
     1. Plot output file :NO.PLT
     2. Plot title       :NO 60 km limb
     3. X-axis label     :wavenumber (cm^-^1)
     4. Y-axis label     :Spectral Radiance (W/sr/cm^2/cm^-^1)
     5. Plot type        :SEMI-LOG PLOT (X LINEAR)
     6. Tic marks        :OUTSIDE GRAPH
     7. X-axis length in inches: 5.0
     8. Y-axis length in inches: 5.0

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{5}
           <Responding with a "5" causes the program to list its       >
           <plot type options and request a selection.                  >
```

```
          PLOT TYPES ARE:
          1 - LINEAR PLOT
          2 - SEMI-LOG PLOT (Y LINEAR)
          3 - SEMI-LOG PLOT (X LINEAR)
          4 - LOG-LOG PLOT

          INPUT YOUR CHOICE
     {3}
                <Selecting plot type "3" causes the program to keep its     >
                <default semi-log radiance (wavenumber linear) form.        >

          THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
          1. Plot output file :NO.PLT
          2. Plot title       :NO 60 km limb
          3. X-axis label     :wavenumber (cm^-^1)
          4. Y-axis label     :Spectral Radiance (W/sr/cm^2/cm^-^1)
          5. Plot type        :SEMI-LOG PLOT (X LINEAR)
          6. Tic marks        :OUTSIDE GRAPH
          7. X-axis length in inches: 5.0
          8. Y-axis length in inches: 5.0

          INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
     {6}
                <Responding with a "6" causes the program to list its tic   >
                <mark options and request a selection.                      >

          TIC MARK TYPES ARE:
          1 - INSIDE GRAPH AXES
          2 - OUTSIDE GRAPH AXES

          INPUT YOUR CHOICE FOR TIC MARK DIRECTION
     {1}
                <The tic marks will now be on the inside of the plot.       >

     THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
          1. Plot output file :NO.PLT
          2. Plot title       :NO 60 km limb
          3. X-axis label     :wavenumber (cm^-^1)
          4. Y-axis label     :Spectral Radiance (W/sr/cm^2/cm^-^1)
          5. Plot type        :SEMI-LOG PLOT (X LINEAR)
          6. Tic marks        :INSIDE GRAPH
          7. X-axis length in inches: 5.0
          8. Y-axis length in inches: 5.0

          INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
     {7}
                <Responding with a "7" causes the program to request a new  >
                <length for the x axis.                                     >

          INPUT THE X-AXIS LENGTH IN INCHES
     {4.0}
                <The x axis will be four inches long.                       >
```

```
     THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
     1. Plot output file :NO.PLT
     2. Plot title       :NO 60 km limb
     3. X-axis label     :wavenumber (cm^-^1)
     4. Y-axis label     :Spectral Radiance (W/sr/cm^2/cm^-^1)
     5. Plot type        :SEMI-LOG PLOT (X LINEAR)
     6. Tic marks        :INSIDE GRAPH
     7. X-axis length in inches: 4.0
     8. Y-axis length in inches: 5.0

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{7}
           <Responding with a "7" causes the program to request a new  >
           <length for the y axis.                                     >

     INPUT THE Y-AXIS LENGTH IN INCHES
{4.0}
           <The y axis will be four inches long.                       >


THE FOLLOWING VARIABLES HAVE BEEN SELECTED:
     1. Plot output file :NO.PLT
     2. Plot title       :NO 60 km limb
     3. X-axis label     :wavenumber (cm^-^1)
     4. Y-axis label     :Spectral Radiance (W/sr/cm^2/cm^-^1)
     5. Plot type        :SEMI-LOG PLOT (X LINEAR)
     6. Tic marks        :INSIDE GRAPH
     7. X-axis length in inches: 4.0
     8. Y-axis length in inches: 4.0

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{0}
           <Free at last.  By responding with a "0" ,the program       >
           <proceeds to the next menu.                                 >

           <The second menu has as defaults the dynamic ranges of      >
           <the x (frequency) and y (radiance) axes.  If only a        >
           <portion of the data is desired for the current plot the    >
           <options 1 and/or 2 should be selected.  The program tries  >
           <to adjust the ranges so that rounded numbers will be       >
           <selected for the tic marks.                                >

     THE FOLLOWING CHARACTERISTICS ARE SET FOR THE CURRENT PLOT:
     1. Minimum frequency          : 1500.0
     1. Maximum frequency          : 4500.049804
     2. Minimum radiance           : 9.999995E-21
     2. Maximum radiance           : 1.000001E-08
     3. Delta x between major ticks: 500.0
     4. Number of minor x ticks    : 4

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{1}
```

```
          <Responding with a "1" causes the program to request new    >
          <lower and upper limits of x (frequency).                   >

     INPUT X-MIN OR MINIMUM FREQUENCY FOR PLOT
{1600}

     INPUT X-MAX OR MAXIMUM FREQUENCY FOR PLOT
{2200}

     THE FOLLOWING CHARACTERISTICS ARE SET FOR THE CURRENT PLOT:
     1. Minimum frequency           : 1600.0
     1. Maximum frequency           : 2200.020019
     2. Minimum radiance            : 9.999995E-21
     2. Maximum radiance            : 1.000001E-08
     3. Delta x between major ticks: 500.0
     4. Number of minor x ticks     : 4

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{2}
          <Responding with a "2" causes the program to request new    >
          <lower and upper limits of y (radiance).                    >

     INPUT Y-MIN OR MINIMUM RADIANCE FOR PLOT
{1e-14}

     INPUT Y-MAX OR MAXIMUM RADIANCE FOR PLOT
{1e-8}

     THE FOLLOWING CHARACTERISTICS ARE SET FOR THE CURRENT PLOT:
     1. Minimum frequency           : 1600.0
     1. Maximum frequency           : 2200.020019
     2. Minimum radiance            : 9.999993E-15
     2. Maximum radiance            : 1.000001E-08
     3. Delta x between major ticks: 500.0
     4. Number of minor x ticks     : 4

     INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT
{3}
          <Responding with a "3" causes the program to request a      >
          <new delta x (frequency interval) between major tics.       >

     INPUT DELTA X BETWEEN MAJOR TICKS
{200}
          <There will be 200 cm^-^1 between major tics.               >

     THE FOLLOWING CHARACTERISTICS ARE SET FOR THE CURRENT PLOT:
     1. Minimum frequency           : 1600.0
     1. Maximum frequency           : 2200.020019
     2. Minimum radiance            : 9.999993E-15
     2. Maximum radiance            : 1.000001E-08
     3. Delta x between major ticks: 200.0
     4. Number of minor x ticks     : 4
```

INPUT ITEM NUMBER TO BE CHANGED OR ZERO TO EXIT

{4}

<Responding with a "4" causes the program to request a >
<new number of minor x ticks. >

INPUT NUMBER OF MINOR X TICKS

{3}

<The number of minor tics has been changed to "3" >

THE FOLLOWING CHARACTERISTICS ARE SET FOR THE CURRENT PLOT:
1. Minimum frequency : 1600.0
1. Maximum frequency : 2200.020019
2. Minimum radiance : 9.999993E-15
2. Maximum radiance : 1.000001E-08
3. Delta x between major ticks: 200.0
4. Number of minor x ticks : 3

Input item number to be changed or zero to exit

{0}

<Free at last. By responding with a "0" the data will be >
<plotted according to the current options. >

The result of the interactive session is that a file named NOSPEC.OUT is read from disk and a plot file named NO.PLT is generated with the labels and specifics generated during the terminal session. The resulting plot is presented in Figure 5.

The plot package allows superscripts, subscripts and Greek symbols to be used in the plot and axis labels. This is accomplished using key characters. Quotes, ", which surround the key characters in this text should not be typed at a terminal session.

¦@ The symbol following a "^" will be plotted as a superscript.

¦@ The symbol following a "\" will be plotted as a subscript.

¦@ The symbol following a "¦" will be replaced by a greek symbol according to Table 16.

¦@ The symbol following a "#" will overwrite the previous symbol, that is a backspace will be performed prior to writing the symbol.

The above key characters can be plotted by preceding them with a "¦". (i.e., "¦¦" will result in a "¦" being plotted, etc.)

TABLE 16. THE KEYS FOR GREEK LETTERS AND SPECIAL CHARACTERS.

KEY	GREEK LETTER	ASCII VALUE
0	CAPITAL GAMMA	48
1	CAPITAL DELTA	49
2	CAPITAL THETA	50
3	CAPITAL LAMBDA	51
4	CAPITAL PI	52
5	CAPITAL SIGMA	53
6	CAPITAL PHI	54
7	CAPITAL PSI	55
8	CAPITAL OMEGA	56
9	INFINITY	57
>	GREATER THAN OR EQUAL TO	62
A	LOWER CASE ALPHA	65
B	LOWER CASE BETA	66
C	LOWER CASE GAMMA	67
D	LOWER CASE DELTA	68
E	LOWER CASE EPSILON	69
F	LOWER CASE ZETA	70
G	LOWER CASE ETA	71
H	LOWER CASE THETA	72
I	DEL OPERATOR	73
K	SCRIPT l	75
L	LOWER CASE LAMBDA	76
M	LOWER CASE MU	77
N	LOWER CASE NU	78
O	LOWER CASE XI	79
P	LOWER CASE PI	80
R	LOWER CASE RHO	82
S	LOWER CASE SIGMA	83
T	LOWER CASE TAU	84
U	LOWER CASE PHI	85
V	LOWER CASE PSI	86
W	LOWER CASE OMEGA	87
X	LOWER CASE CHI	88
Y	VECTOR HAT	89
[	RIGHT ARROW	91
]	LEFT ARROW	93

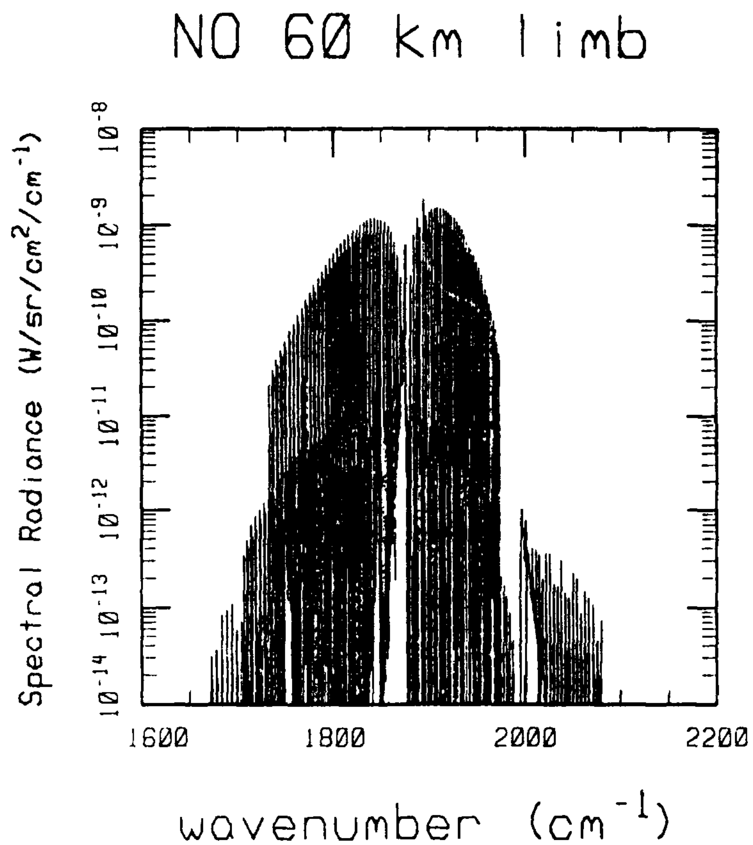

Figure 5. Sample NO Spectral Radiance Plot Created During Interactive Session.

7. REFERENCES

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APPENDIX A

IMPLEMENTATION INSTRUCTIONS

The magnetic tape is unlabeled, ASCII-coded, 1600 BPI and contains the FORTRAN source code, input data sets and three test cases for the Strategic High-Altitude Radiance Code, SHARC. This model calculates the spectral radiance from 250 to 5000 cm^{-1} for arbitrary geometries from 60 to 300 km. SHARC includes radiance from CO_2, H_2O, NO, O3, and CO.

The tape contains 50 files. There are a total of ten FORTRAN files: seven for SHARC, one for the interpreter, one for the plotting package and one for the ASCII to binary conversion program. The others consist of nine model atmosphere files, one generic input file, 15 input files for the five current molecular radiators, one ASCII line position and strength file, five interpreter output files, and input and output files from three test cases. The input and output for the test cases are included in Appendices E and F of this manual. The test cases run on a Hewlett-Packard 9040, Series 500, minicomputer which has a 32-bit word size.

The tape format is:

9 track
1600 BPI
unlabeled ASCII
50 files
80 characters per record (files 1-35)
132 characters per record (files 36-50)
20 records per block.

The files are:

1	sharc	Main program	FORTRAN	588 lines
2	chemkin	CHEMKIN subroutines	FORTRAN	1068 lines
3	geomtry	Geomtry subroutines	FORTRAN	874 lines
4	input	Input subroutines	FORTRAN	3840 lines
5	nemesis	NEMESIS subroutines	FORTRAN	1209 lines
6	output	Output subroutines	FORTRAN	1092 lines
7	spctra	Spectral Radiance subroutines	FORTRAN	1042 lines
8	interp	CHEMKIN Interpreter program	FORTRAN	2151 lines

9	pltpak	Plotting Package	FORTRAN	3609 lines
10	binary	Program to convert Line data base to binary	FORTRAN	33 lines
11	SAT1976.DAT	1976 Standard	DATA	319 lines
12	SAT15AN.DAT	15^{o} Annual	DATA	951 lines
13	SAT30SM.DAT	30^{o} Summer	DATA	951 lines
14	SAT30WN.DAT	30^{o} Winter	DATA	951 lines
15	SAT45SP.DAT	45^{o} Spring/Fall	DATA	951 lines
16	SAT45SM.DAT	45^{o} Summer	DATA	951 lines
17	SAT45WN.DAT	45^{o} Winter	DATA	951 lines
18	SAT60SM.DAT	60^{o} Summer	DATA	951 lines
19	SAT60WN.DAT	60^{o} Winter	DATA	951 lines
20	SHARC.INP	Default Input File	DATA	116 lines
21	CO2BAND.DAT	CO_2 Band Information file	DATA	349 lines
22	CO2KIN.DAT	CO_2 Kinetics file	DATA	252 lines
23	CO2STAT.DAT	CO_2 Transitions and State file	DATA	54 lines
24	COBAND.DAT	CO Band Information file	DATA	34 lines
25	COKIN.DAT	CO Kinetics file	DATA	36 lines
26	COSTAT.DAT	CO Transitions and State file	DATA	11 lines
27	H2OBAND.DAT	H_2O Band Information file	DATA	164 lines
28	H2OKIN.DAT	H_2O Kinetics file	DATA	82 lines
29	H2OSTAT.DAT	H_2O Transitions and State file	DATA	27 lines
30	NOBAND.DAT	NO Band Information file	DATA	37 lines
31	NOKIN.DAT	NO Kinetics file	DATA	32 lines
32	NOSTAT.DAT	NO Transitions and State file	DATA	11 lines
33	O3BAND.DAT	O_3 Band Information file	DATA	263 lines
34	O3KIN.DAT	O_3 Kinetics file	DATA	199 lines
35	O3STAT.DAT	O_3 Transitions and State file	DATA	46 lines
36	LINE.ASC	ASCII Version of Line Parameter File	DATA	95659 lines
37	CO2OUT.DAT	CO_2 Interpreter output	DATA	360 lines
38	COOUT.DAT	CO Interpreter output	DATA	72 lines
39	H2OOUT.DAT	H_2O Interpreter output	DATA	133 lines
40	NOOUT.DAT	NO Interpreter output	DATA	64 lines
41	O3OUT.DAT	O_3 Interpreter output	DATA	326 lines

FIRST TEST CASE

42 SHARC1.INP	Test default file	DATA	116 lines
43 SHARC1.OUT	General output	DATA	1366 lines
44 SHARC1.SPC	Spectral file	DATA	4543 lines

SECOND TEST CASE

45 SHARC2.INP	Test default file	DATA	116 lines
46 SHARC2.OUT	General output	DATA	1258 lines
47 SHARC2.SPC	Spectral file	DATA	445 lines

THIRD TEST CASE

48 SHARC3.INP	Test default file	DATA	116 lines
49 SHARC3.OUT	General output	DATA	113 lines
50 SHARC3.SPC	Spectral file	DATA	445 lines

The FORTRAN source code for SHARC is found in the first seven files on the tape. These files should be compiled and linked to make the executable version of SHARC. The only system-dependent routine is subroutine DATE which is in the input file. This routine should return the date in a CHARACTER*32 variable called ADATE. All of the file open statements are in the main SHARC routine, and may need to be changed for your machine. The SHARC subroutines are listed in Appendix C, and execution of SHARC is described in Section 4.

The INTERPRETER should be compiled as a stand-alone program. INTERPRETER subroutines are described in Appendix B and use of the program is discussed in Section 4.

The plotting package should be compiled as a stand-alone program. System-dependent routines which are required in the plotting package are discussed in Appendix D.

The routine called binary converts the ASCII line parameter file shipped on the tape to a binary form for SHARC. Binary should be compiled as a stand-alone program. When binary is executed it reads a file called LINE.ASC and outputs a binary version of the file. The new file is called SHARC.LIN. The conversion of LINE.ASC to SHARC.LIN is performed only once.

APPENDIX B

INTERPRETER SUBROUTINES

The INTERPRETER reads this symbolic description of an arbitrary chemical kinetics mechanism and translates it into the appropriate differential equations. The output from the INTERPRETER used by SHARC is a binary "linking" file which contains all the information describing the kinetic mechanism for a given molecular radiator.

A list of the subroutines comprising the INTERPRETER with a brief description follows.

<u>MAIN</u> MAIN opens the input and output files used by the INTERPRETER, and defines the following parameters used to set the maximum size of storage arrays:

KMX (=100)	The maximum number of species allowed during the execution of the INTERPRETER.
LENSYM(=10)	The maximum length of a species symbol.
MXLEN (=80)	The maximum length of a reaction input string.
MAXSP (=8)	The maximum number of species allowed in any given reaction.
MAXTB (=6)	The maximum number of third bodies allowed in any given reaction.

<u>CKINTP</u> CKINTP is the driver routine which reads the species and reaction mechanism input, checks for proper syntax, and writes the "linking" file.

<u>BLKDAT</u> Block data defines the Hollerith characters for the species, as well as a number of Hollerith constants used in the code.

<u>CKTBD</u> This subroutine checks to make sure that different third-body efficiency factors have not been input for any species.

<u>CKINTC</u> This routine converts a character input string into internal code.

<u>CKNUM</u> CKNUM converts a character string into a specified number of real numbers. The character string may contain integer, floating point, or exponential numbers separated by at least one blank.

__CKSCAN__ This subroutine scans a character string (in internal code) and converts all digits into integer numbers and all species into species indicies.

__CKPARS__ CKPARS checks the input string for format errors (i.e., enforce the rules given in Section 3.1)

__CKERR__ This subroutine writes the error messages into the output file.

APPENDIX C

SHARC SUBROUTINES

A list of the subroutines comprising the various SHARC modules described in Section 2.2 is given below.

MAIN — The SHARC MAIN routine opens the input and output files used by SHARC, and calls: the input and output routines, the CHEMKIN/NEMESIS driver, the GEOMETRY module, and the SPCRAD module. MAIN also defines the following parameters used to determine the size of various arrays.

NBINMX(=10000)	Maximum number of radiance bins.
NBMAX (=30)	Maximum number of bands.
NBYMAX(=61)	The maximum number of layer boundaries.
NCHMAX(=80)	Maximum length of reaction input string.
NDFLTS(=20)	The number of lines of input in SHARC.INP.
NIMAX(=200)	The maximum number of reactions.
NKMAX (=50)	The maximum number of species allowed.
NLNMAX(=10)	The maximum length of a species symbol.
NLYMAX(=60)	The maximum number of layers in model atmosphere.
NRDMX (=5)	Maximum number of molecular emitters.
NSMAX (=20)	The maximum number of bins for band distributions.
NSPMAX (=8)	The maximum number of species allowed in any given reaction.
NTBMAX (=6)	The maximum number of third bodies allowed in any given reaction.

INPUT Module

ATMDEN — This subroutine loads atmospheric profile into the appropriate local arrays and calculates the thickness of the atmospheric layers.

ATMIN — ATMIN identifies the atmospheric species in the general species list, and reads atmospheric profile (containing the species number densities and kinetic temperature).

ATMSYM — ATMSYM sets up the Hollerith arrays identifying the atmospheric species and an indexing array which relates the atmospheric species to the species read by CKLINK.

BANDIN — BANDIN reads the molecular bands file (Section 3.3), which describes the line strength distribution function parameters for each vibrational transition.

BLKDAT — BLOCK DATA contains some fundamental constants, species molecular weights, the average atmospheric temperature for NEMESIS, and the optical depth cutoff parameter for the relayering option.

DATE — DATE calls a system-dependent routine to determine the date and time of the SHARC run.

ACTIVE — This function reads the first parameter in the SHARC.INP input file. If active is 1 SHARC runs interactively, if active is 0 SHARC runs in the batch/background mode.

FILCHK — This routine opens all molecular input files to insure that the files really exist before any computational time has been used.

INATM — This is the interactive input routine for reviewing/changing the user's choice of model atmosphere.

INGEO — This is the interactive LOS geometry routine. The user can review and change the selected LOS geometry.

INMOL — This is the interactive input routine for reviewing/changing the desired molecular radiators. Currently the code supports H_2O, CO_2, O_3, CO, and NO.

INNAME — This is the interactive input routine for reviewing/changing the title of the calculation.

LENS — This function counts the number of characters in the title.

INNEM — This is the input routine for reviewing/changing the NEMESIS parameters.

INOUT — This routine allows the user to review and/or modify the amount of output place in the general output file.

INPOP — This routine allows the user to review and/or modify the name and status of the population file.

INSOL — This routine is used to change/review the solar zenith angle.

INSPEC This is the interactive input routine used to change and/or modify the spectral range and resolution. The relayering option is also selected in this menu.

LOADDE This routine opens and loads the input data found in SHARC.INP into the array DFLTS. IF SHARC.INP is not found this routine loads in a default set of parameters.

POLL This routine contains the main interactive input module menu and reads the user's choice.

RADIN This subroutine reads the molecular states file (Section 3.2), which contains the molecular radiator, the vibrational states included in the mechanism and the transitions to be considered by NEMESIS and SPCRAD.

READRD READRD reads the list of molecular radiators and the names of the associated linking, states, and bands files.

RETREV This routine reads the saved population file data.

XNUM XNUM translates an alphanumeric character string containing N integer, real, or exponential numbers into their respective real values.

CHEMKIN Module

CKLINK CKLINK reads the "linking" file created by INTERP, and defines the arrays containing information on species names, chemical kinetics mechanism (i.e., the stoichiometric coefficients) and the rate constants.

LUDCMP/LUBKSB These two subroutines use a LU decomposition procedure to solve a set of simultaneous linearly independent algebraic equations (the steady-state equations). The major limitation to the steady-state procedure used here is the assumption that the rate equations are linear in the unknown vibrational population, i.e., there is no energy exchange among the emitting species. This restriction can be easily relaxed by using an algorithm which solves nonlinear equations (as opposed to LUDCMP/LUBKSB).

POPLTE This subroutine computes the LTE populations for N_2 and O_2 which are subsequently used in the calculation of vibrationally excited states for CO and H_2O.

POPN2 This subroutine computes the effective excited state populations for N_2 using the Kumer and James approach.

RATCON This subroutine uses the kinetic data from the linking file to compute the rate constants as a function of temperature. The assumed from of the rate constant is

$$k = A\, T^{\beta} \exp(-E/T - C/T^{1/3}) \quad ,$$

where A is the pre-exponential factor, β is the exponent of the temperature term, E is the activation energy (can also be used to write a reverse rate constant in terms of the forward rate constant via detailed balance), and C is the (historic) SSH $T^{1/3}$ coefficient.

RATSCL This subroutine computes the effective rate constant for the $CO_2(00011)$ + $N_2(0)$ quenching process following Kumer and James.

STEADY The information obtained from CKLINK is used by STEADY to set up the steady state equations

$$\sum_{i=1}^{I} (\nu'_{ki} - \nu_{ki}) k_i \prod_{k=1}^{K} [C_k]^{\nu_{ki}} = 0 \quad .$$

STEADY then calls LUDCMP and LUBKSB to solve the set of linear algebraic equations for the number densities c_k.

NEMESIS Module

ARATE ARATE solves the two-state steady-state equation for the atmospheric excitation rate constant.

COLDEN COLDEN computes the total column density for each atmospheric layer for the radiating species.

DOPLER This subroutine determines the emission frequency using a Doppler lineshape function. The absorption cross section at this frequency is also computed.

DWIDTH DWIDTH calculates the Doppler halfwidth for the transition.

E2 E2 computes the second exponential integral as a function of optical depth.

EMISS This subroutine locates the Einstein A coefficient for the

current transition, and also calculates the sum of all Einstein A coefficients for all transitions from the upper vibrational state.

<u>ERATE</u> ERATE calculates the earthshine excitation rate for each atmospheric layer.

<u>ESCPRB</u> ESCPRB normalizes the escape probabilities calculated by subroutine PATH for each layer.

<u>ESHINE</u> ESHINE calculates the earthshine flux for the current transition using the specified effective earthshine temperature.

<u>EWIDTH</u> EWIDTH calculates the equivalent width for a Doppler line.

<u>GASDEV</u> GASDEV generates random numbers from a Gaussian distribution centered around 0.

<u>MULSCT</u> MULSCT calculates the nth-order multiple scattering enhancement to the excited-state number density using the single-scattering enhancement matrix.

<u>NEMDRV</u> This subroutine calls the appropriate CHEMKIN/NEMESIS subroutines to compute the vibrationally excited state populations.

<u>NEMRXN</u> NEMRXN identifies the excitation and relaxation processes in the chemical kinetics mechanism for the current transition being considered by NEMESIS.

<u>NEMSIS</u> NEMSIS is the driver routine to compute the escape probabilities and enhanced excited-state number densities for each atmospheric layer using Monte Carlo integration of atmospheric layers, line strengths, and frequencies.

<u>PATH</u> PATH integrates through the atmospheric layers to determine the escape probabilities and single-scattering enhancements.

<u>PICKSJ</u> PICKSJ determines the line strength selected from the line strength distribution function.

<u>PICKZ</u> PICKZ finds the initial location and the corresponding layer for photon emission.

<u>QUENCH</u> This subroutine computes the total quenching rate for the upper state of the transition.

<u>RANF</u> This machine-dependent function generates uniformly distributed random numbers between 0 and 1.

SOLAR This subroutine calculates the solar flux at the transition frequency assuming a 5500 K blackbody.

SRATE SRATE calculates the solar excitation rate for each atmospheric layer.

GEOMETRY Module

AMOUNT This subroutine calculates column densities COLUMN(i,j) for the i^{th} segment, SEG(i), and j^{th} species. These are obtained by multiplying the segment length by average species concentrations.

GEOMET This subroutine accepts as input a minimal set of LOS parameters. The minimal set depends on desired path type as flagged by IPATH and ICASE. The output of GEOMET is a complete set of LOS parameters.

IPATH2 This subroutine is called from GEOMET if IPATH = 2. The input to this subroutine is a minimal set of LOS parameters; the output is a complete set of such parameters.

IPATH3 This subroutine is called from GEOMET if IPATH = 3. The input to this subroutine is a minimal set of LOS parameters; the output is a complete set of such parameters.

IPATH4 This subroutine is called from GEOMET if IPATH = 4. The input to this subroutine is a minimal set of LOS parameters; the output is a complete set of such parameters.

LOS This subroutine calculates the parametric equation of the straight line that is the LOS. Thus the quantities that are calculated are the unit direction vector of LOS in the direction which points from the observer position to the source position, and a position on the straight line which is taken to be that of the observer.

PASECT This subroutine, using the equation of the LOS and its length (RANGE), calculates which layer boundaries are intersected by the LOS, and the distances of these intersections from the observer.

LINRD This routine reads the binary line parameter file, one line at a time.

PRTROT This routine calculates the rotational partition function.

RELAYR This routine relayers a n layer atmosphere into $\sqrt{n}$ layers. The use of a relayered atmosphere is limited to optically thin lines and is a user-selected option.

SPCRAD This is the spectral radiance routine and is called by the main SHARC routine. This routine calls LINRD to read an individual line, calls BNDLOC to determine if this line is for a user-selected transition, calls STRGTH to scale the line strength to the proper rotational and vibrational temperatures and calls WVOIGT to calculate the equivalent width for the line. The end result of this routine is the spectral radiance for a line which is stored in array RADBIN.

STRGTH STRGTH scales the line strength to the current vibrational and rotational temperatures. The reference temperature of 296K has already been removed from the SHARC line parameter database.

VIBES When ICHOIC=1 this routine converts 1982 vibrational assignments to 1985 format. When ICHOIC=2 the routine converts 1985 format to 1982 vibrational assignments. This routine is from the HITRAN line selection program.

WVOIGT This routine calculates an equivalent width for an isolated Doppler-Lorentzian (Voigt) line. This routine uses an approximation from the NASA IR Handbook that is good to 10% for all optical depths.

OUTPUT Module

AFGLNK AFGLNK associates the AFGL number with each atmospheric species.

ATMOUT ATMOUT prints the atmospheric profile.

BANNER BANNER outputs the SHARC banner identifying the run.

BNDOUT This subroutine prints the line strength distribution function parameters.

BRDOUT BRDOUT summarizes the calculated band radiances for each transition. The number of lines used in the radiance calculation is also printed.

SL Solves for the points of intersection between a line and a sphere. SL is used by PASECT. It uses the subroutine QUAD which is a quadratic equation solver.

QUAD This is a quadratic equation solver used by subroutine SL.

SORT This subroutine sorts the outputs of PASECT which are the arrays of layer boundaries intersected, and of the distances of the intersections from observer to source.

SGMNT SGMNT outputs the array SEG which contain the "intralayer" distances of the LOS in order of traversal from observer to source. It also computes an integer array MINLR which contains the lower layer boundary of each segment.

PRSCAL This subroutine is used to calculate the total pressure of the atmospheric layers containing the LOS. It uses the atmosphere data file to obtain gas concentrations and temperatures, and calculates pressure via the ideal gas law.

ASNCHK The input to this subroutine is the argument to any ASIN or ACOS call. Its purpose is to force the argument to lie within the range of -1 to 1, and print a warning message if it is not. If the input to ASNCHK is within range then ASNCHK does nothing.

CHECK This subroutine performs a cursory check on the LOS inputs to GEOMET. GEOMET calls CHECK prior to calling the IPATHn routines. CHECK terminates further SHARC execution when it encounters faulty inputs.

RCHECK This is an auxiliary routine used by CHECK to perform range checking on an argument.

SPCRAD Module

BNDLOC This subroutine compares the transition listed on the HITRAN tape and the transitions the user has selected to include in the calculation.

COLDNL This routine calculates the column densities of excited-state species along the LOS.

CRTGDS This routine calculates column density weighted line widths.

AD-A207 667 THE STRATEGIC HIGH-ALTITUDE ATMOSPHERIC RADIATION CODE 2/2
(SHARC) USER INSTR (U) SPECTRAL SCIENCES INC
BURLINGTON MA R L SUNDBERG ET AL. 03 FEB 89 SSI-TR-152
UNCLASSIFIED AFGL-TR-89-0062 F19628-87-C-0130 F/G 4/1 NL

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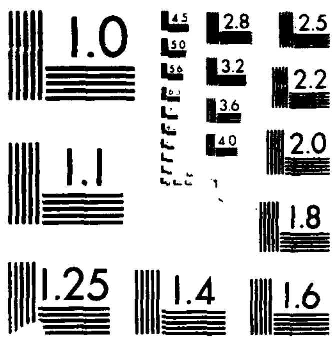
DTIC


1.0
4.5
5.0
5.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

DUMPDE This routine writes a new SHARC.INP file, after it has been updated through the interactive menus.

EMTOUT This subroutine outputs the user-selected list of molecular radiators.

EXCOUT EXCOUT outputs the number densities as a function of altitude for each vibrational state in the mechanism.

GEMOUT GEMOUT writes out a breif summary of the LOS information to SHARC.OUT.

NEMOUT This subroutine prints out some of the inputs used by NEMESIS.

POPTMP POPTMP returns a vibrational temperature when passed the populations of two levels and the energy gap between them.

RADOUT RADOUT outputs the information contained in the molecular states file.

RETOUT RETOUT writes a summary of the population file to SHARC.OUT when an old population file is used in a new calculation.

SAVE SAVE writes the population file.

SPCOUT SPCOUT writes the spectral radiance as a function of wavenumber to SHARC.SPC.

VBTOUT VBTOUT outputs the vibrational temperatures as a function of altitude for each vibrational state in the mechanism.

VIBTMP This routine calculates vibrational temperatures of excited-state species.

APPENDIX D

PLOTTING PACKAGE

The plotting software is a separate package which can be used to plot the spectral output of a SHARC computation. The program is written in Fortran 77. The program is designed to be as device independent as possible. It requires only standard Calcomp calls to initialize and terminated plotting, and a standard Calcomp call to move the pen. External routines which must be supplied by the user include <u>INITPZ</u>, <u>ENDPLT</u> and <u>PPLT</u> which are described below. All other aspects of plotting are device independent.

<u>INITPZ</u> This subroutine initializes all system specific requirements for plotting and opens the plot file. Subroutine arguments are:

<u>PLTFIL</u> - a character string which is the name of the plot file to be sent to the printer/plotter,

<u>NCPPLT</u> - an integer equal to the number of characters in the plot file name,

<u>NPLT</u> - the file unit number for the plot file.

<u>NERR</u> - the file unit number for writing any error messages.

<u>ENDPLT</u> ENDPLT terminates plotting and closes the plot files.

<u>PPLT</u> PPLT draws a line or moves the pen to a new set of (X,Y) coordinates relative to the current origin. Subroutine arguments are:

<u>X</u> - a real number giving the x position of the pen,

<u>Y</u> - a real number giving the y position of the pen,

<u>IPEN</u> - a pen control parameter. IPEN has the following meaning:

2	Lower pen and move
3	Raise pen and move
-2	Lower pen, move and reset origin to x,y
-3	Raise pen, move and reset origin to x,y

APPENDIX E

TEST CASE -- INPUTS

This appendix includes the SHARC input files for three test cases. The output generated from these input files is contained in Appendix F. The first file is for a batch/background calculation. The second and third files are for interactive execution.

<u>SHARC.INP for test 1, called SHARC1.INP in Appendix A.</u>

```
C0 FILE SHARC.INP
C0 THIS FILE HOLDS THE DEFAULT VALUES FOR SHARC
C0 THIS FILE IS UPDATED TO THE CURRENT VALUES OF THE PARAMETERS
C0 EACH TIME SHARC IS RUN.
C0
C1 THE FIRST LINE CONTAINS THE INTERACTIVE/BATCH OPTION
C1 IF IT EQUALS 1, SHARC WILL RUN INTERACTIVELY, ALLOWING
C1 THE USER TO UPDATE OPTIONS.  IF IT EQUALS 0, SHARC WILL
C1 RUN IN BATCH MODE. THIS WILL NOT ALLOW THE USER TO UPDATE SHARC.INP.
C1 THIS FILE MUST BE EDITTED TO CHANGE THE VALUE OF THIS PARAMETER.
C1 FORMAT = I4
C1##
   0
C2 TITLE FOR CALCULATION   WILL APPEAR ON TOP OF GENERAL OUTPUT FILE
C2 FORMAT(1X,A68,I3)
C#################################################################### ###
 CO, CO2, NO, H2O, O3  DAYTIME  1976 STANDARD ATMOSPHERE               55
C3 LINE 2 CONTAINS THE VARIABLE IATMOS.
C3 THIS VARIABLE IS USED TO SELECT THE DESIRED MODEL ATMOSPHERE AND
C3 THE ATMOSPHERIC FILE NAME.
C3 FORMAT = I4,2X,A11
C3##  ###########
   1  SAT1976.DAT
C4 LINE 3 CONTAINS THE EXO-ATMOSPHERIC TEMPERATURE AND
C4 A CONTROL PARAMETER WHICH SELECTS EITHER THE DAY(4) OR NIGHT(3)
C4 OPTION FOR THE MODEL ATMOSPHERE.
C4 FORMAT = E12.5,2X,A5
C4 #####E+##  #####
  .10000E+04  DAY
C5 NEMESIS CONTROL PARAMETERS
C5 WARNING: CHANGING THESE PARAMETERS WILL EFFECT THE ACCURACY
C5 OF THE MONTE CARLO SIMULATION.
C5 TOTAL NUMBER OF PHOTONS, MAXIMUM ORDER OF SCATTERING
C5 GLOBAL SUNSHINE AND EARTHSHINE PARAMETERS (1=YES , 0=NO)
```

```
C5 FORMAT=2X,6I,2X,6I,2x,I6,2X,I6
C5 ##### ###### ###### ######
   10000     200        1        1
C6 AFGL# FOR MOLECULE,LINKING FILE, STATE FILE, BAND FILE
C6 UP TO 5 RADIATORS H2O=1, CO2=2, O3=3, CO=5, NO=8
C6FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C6#### ########### ########### ###########
     1  H2OLINK.DAT  H2OSTAT.DAT  H2OBAND.DAT
C7 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C7#### ########### ########### ###########
     2  CO2LINK.DAT  CO2STAT.DAT  CO2BAND.DAT
C8 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C8 ### ########### ########### ###########
     3  O3LINK.DAT   O3STAT.DAT   O3BAND.DAT
C9 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C9 ### ########### ########### ###########
     5  COLINK.DAT   COSTAT.DAT   COBAND.DAT
C10FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C10### ########### ########### ###########
     8  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C11 SOLAR ZENITH ANGLE IN DEGREES. 0 FOR THE SUN OVERHEAD
C11( 0.0 WHEN THE SUN IS OVERHEAD)
C11FORMAT = E12.5
C#.#####E+##
  .20000E+02
C12NEXT 6 LINES CONTAIN LOS GEOMETRY INFORMATION
C12LINE 12 CONTAINS IPATH AND ICASE
C12FORMAT = I4,2X,I4
C12#  ####
   2     5
C13LINE 13 CONTAINS H1ALT, H1LONG AND H1LAT
C13FORMAT = 3(E12.7,2X)
C13#####E+##  .#######E+##  .#######E+##
.7000000E+02  .6200000E+02  .5000000E+02
C14LINE 14 CONTAINS H2ALT, H2LONG AND H2LAT
C14FORMAT = 3(E12.7,2X)
C14#####E+##  .#######E+##  .#######E+##
.2900000E+03  .6200000E+02  .6000000E+02
C15LINE 15 CONTAINS RANGE,BETA,AO
C15FORMAT = 3(E13.8,1x)
C15######E+## .########E+## .########E+##
 .6000000E+02  .1200000E+03  .0000000E+00
C16LINE 16 CONTAINS BO,HMIN,LEN
C16FORMAT = 2(E13.8,1x),I4
C16######E+## .########E+## ####
 .9000000E+02  .6000000E+02    0
C17Line 17 CONTAINS TIME,IDAY,ICASES
C17TIME IS GMT TIME (0. TO 24.)
C17IDAY IS FROM 1 TO 366
C17THESE OPTIONS ARE NOT USED IN SHARC-1
C17FORMAT = E12.7,2X,2I4
C17#####E+##  #### ###
```

```
.0000000E+00      6    1
C18SPECTRAL INFORMATION IN CM-1
C18 WMIN,WMAX,BINRES(RESOLUTION),IRELAY=1 FOR RELAYERING
C18FORMAT = 2X,3(E12.5,2X),I2,2X,E12.5
C18#.#####E+##  ##.#####E+##  ##.#####E+##  ##
    .25000E+03    .50000E+04    .10000E+01   0
C19 OUTPUT CONTROL PARAMETERS:
C19 1) MODEL ATMOSPHERE OUTPUT ==>1 FOR FULL LISTING
C19 2) ATMOSPHERIC MOLECULE IDENTIFICATION == >2 FOR TABLE
C19 3) MOLECULAR RADIATORS INFORMATION ==>2 FOR ECHO OF INPUTS
C19 4) NOT CURRENTLY USED
C19 5) SELECTED TRANSITIONS ==>1 FOR TRANSITIONS SELECTED
C19 6) MOLECULAR BAND INFORMATION ==>2 FOR ECHO OF BAND INFORMATION
C19 7) NEMESIS OUTPUT ==>1 NEMESIS ONLY ==2 FOR POST POPULATIONS
C19 8) FINAL STATE POPULATIONS ==>1 YES
C19 9) FINAL VIBRATIONAL TEMPERATURES ==>1 YES
C19 10)LOS OUTPUT ==>1 FOR COLUMN DENSITIES
C19 11)CURRENTLY NOT USED
C19 12)SPECTRAL RADIANCE OUTPUT ==>1 FOR RADIANCE OUTPUT IN GENERAL
C19    OUTPUT FILE  SPECTRAL INFORMATION IS ALWAYS PLACED IN SPEC.OUT
C19 FORMAT = 12(2X,I2)
C  1   2   3   4   5   6   7   8   9  10  11  12
C ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##
   1   0   0   0   1   0   0   1   1   1   0   0
C20 SAVED POPULATIONS FILE NAME AND ISAVE
C20 WHEN ISAVE = 0 POPULATIONS ARE SAVED
C20 ISAVE = 1 SAVED POPULATIONS ARE USED FOR CALCULATION
C20 FORMAT=(2X,A20,2X,I4)
C2####################  ####
  D1976.DAT                1
```

SHARC.INP for test 2, called SHARC2.INP in Appendix A.

```
CO FILE SHARC.INP
CO THIS FILE HOLDS THE DEFAULT VALUES FOR SHARC
CO THIS FILE IS UPDATED TO THE CURRENT VALUES OF THE PARAMETERS
CO EACH TIME SHARC IS RUN.
CO
C1 THE FIRST LINE CONTAINS THE INTERACTIVE/BATCH OPTION
C1 IF IT EQUALS 1, SHARC WILL RUN INTERACTIVELY, ALLOWING
C1 THE USER TO UPDATE OPTIONS.  IF IT EQUALS 0, SHARC WILL
C1 RUN IN BATCH MODE. THIS WILL NOT ALLOW THE USER TO UPDATE SHARC.INP.
C1 THIS FILE MUST BE EDITTED TO CHANGE THE VALUE OF THIS PARAMETER.
C1 FORMAT = I4
C1##
   1
C2 TITLE FOR CALCULATION   WILL APPEAR ON TOP OF GENERAL OUTPUT FILE
C2 FORMAT(1X,A68,I3)
C#################################################################### ###
 CO   NIGHT  WINTER  45-LATITUDE                                       31
C3 LINE 2 CONTAINS THE VARIABLE IATMOS.
C3 THIS VARIABLE IS USED TO SELECT THE DESIRED MODEL ATMOSPHERE AND
C3 THE ATMOSPHERIC FILE NAME.
C3 FORMAT = I4,2X,A11
C3##  ###########
   7  SAT45WN.DAT
C4 LINE 3 CONTAINS THE EXO-ATMOSPHERIC TEMPERATURE AND
C4 A CONTROL PARAMETER WHICH SELECTS EITHER THE DAY(4) OR NIGHT(3)
C4 OPTION FOR THE MODEL ATMOSPHERE.
C4 FORMAT = E12.5,2X,A5
C4 ######E+##  #####
  .15000E+04  NIGHT
C5 NEMESIS CONTROL PARAMETERS
C5 WARNING: CHANGING THESE PARAMETERS WILL EFFECT THE ACCURACY
C5 OF THE MONTE CARLO SIMULATION.
C5 TOTAL NUMBER OF PHOTONS, MAXIMUM ORDER OF SCATTERING
C5 GLOBAL SUNSHINE AND EARTHSHINE PARAMETERS (1=YES , 0=NO)
C5 FORMAT=2X,6I,2X,6I,2x,I6,2X,I6
C5 #####  ######  ######  ######
   10000     200       0       1
C6 AFGL# FOR MOLECULE,LINKING FILE, STATE FILE, BAND FILE
C6 UP TO 5 RADIATORS H2O=1, CO2=2, O3=3, CO=5, NO=8
C6FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C6####  ###########  ###########  ###########
     5  COLINK.DAT   COSTAT.DAT   COBAND.DAT
C7 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C7####  ###########  ###########  ###########
     0  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C8 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C8 ###  ###########  ###########  ###########
     0  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C9 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
```

```
C9 ###  ###########  ###########  ###########
      0  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C10FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C10###  ###########  ###########  ###########
      0  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C11 SOLAR ZENITH ANGLE IN DEGREES. 0 FOR THE SUN OVERHEAD
C11( 0.0 WHEN THE SUN IS OVERHEAD)
C11FORMAT = E12.5
C#.#####E+##
  .15000E+02
C12NEXT 6 LINES CONTAIN LOS GEOMETRY INFORMATION
C12LINE 12 CONTAINS IPATH AND ICASE
C12FORMAT = I4,2X,I4
C12#  ####
   4     5
C13LINE 13 CONTAINS H1ALT, H1LONG AND H1LAT
C13FORMAT = 3(E12.7,2X)
C13#####E+##   .#######E+##   .#######E+##
.7000000E+02  .6200000E+02  .5000000E+02
C14LINE 14 CONTAINS H2ALT, H2LONG AND H2LAT
C14FORMAT = 3(E12.7,2X)
C14#####E+##   .#######E+##   .#######E+##
.2900000E+03  .6200000E+02  .7000000E+02
C15LINE 15 CONTAINS RANGE,BETA,A0
C15FORMAT = 3(E13.8,1x)
C15######E+## .########E+## .########E+##
 .6000000E+02  .1200000E+03  .0000000E+00
C16LINE 16 CONTAINS B0,HMIN,LEN
C16FORMAT = 2(E13.8,1x),I4
C16######E+## .########E+## ####
 .9000000E+02  .1000000E+03    0
C17Line 17 CONTAINS TIME,IDAY,ICASES
C17TIME IS GMT TIME (0. TO 24.)
C17IDAY IS FROM 1 TO 366
C17THESE OPTIONS ARE NOT USED IN SHARC-1
C17FORMAT = E12.7,2X,2I4
C17#####E+##  #### ###
.0000000E+00     6   1
C18SPECTRAL INFORMATION IN CM-1
C18 WMIN,WMAX,BINRES(RESOLUTION),IRELAY=1 FOR RELAYERING
C18FORMAT = 2X,3(E12.5,2X),I2,2X,E12.5
C18#.#####E+##  ##.#####E+##  ##.#####E+##  ##
    .19000E+04    .45000E+04    .10000E+01   1
C19 OUTPUT CONTROL PARAMETERS:
C19 1) MODEL ATMOSPHERE OUTPUT ==>1 FOR FULL LISTING
C19 2) ATMOSPHERIC MOLECULE IDENTIFICATION == >2 FOR TABLE
C19 3) MOLECULAR RADIATORS INFORMATION ==>2 FOR ECHO OF INPUTS
C19 4) NOT CURRENTLY USED
C19 5) SELECTED TRANSITIONS ==>1 FOR TRANSITIONS SELECTED
C19 6) MOLECULAR BAND INFORMATION ==>2 FOR ECHO OF BAND INFORMATION
C19 7) NEMESIS OUTPUT ==>1 NEMESIS ONLY ==2 FOR POST POPULATIONS
C19 8) FINAL STATE POPULATIONS ==>1 YES
```

```
C19 9) FINAL VIBRATIONAL TEMPERATURES ==>1 YES
C19 10)LOS OUTPUT ==>1 FOR COLUMN DENSITIES
C19 11)CURRENTLY NOT USED
C19 12)SPECTRAL RADIANCE OUTPUT ==>1 FOR RADIANCE OUTPUT IN GENERAL
C19    OUTPUT FILE  SPECTRAL INFORMATION IS ALWAYS PLACED IN SPEC.OUT
C19 FORMAT = 12(2X,I2)
C  1   2   3   4   5   6   7   8   9  10  11  12
C ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##
   1   2   2   0   1   2   2   1   1   1   0   1
C20 SAVED POPULATIONS FILE NAME AND ISAVE
C20 WHEN ISAVE = 0 POPULATIONS ARE SAVED
C20 ISAVE = 1 SAVED POPULATIONS ARE USED FOR CALCULATION
C20 FORMAT=(2X,A20,2X,I4)
C2####################  ####
  CO45WIN.DAT             0
```

SHARC.INP for test 3, called SHARC3.INP in Appendix A.

```
CO FILE SHARC.INP
CO THIS FILE HOLDS THE DEFAULT VALUES FOR SHARC
CO THIS FILE IS UPDATED TO THE CURRENT VALUES OF THE PARAMETERS
CO EACH TIME SHARC IS RUN.
CO
C1 THE FIRST LINE CONTAINS THE INTERACTIVE/BATCH OPTION
C1 IF IT EQUALS 1, SHARC WILL RUN INTERACTIVELY, ALLOWING
C1 THE USER TO UPDATE OPTIONS.  IF IT EQUALS 0, SHARC WILL
C1 RUN IN BATCH MODE. THIS WILL NOT ALLOW THE USER TO UPDATE SHARC.INP.
C1 THIS FILE MUST BE EDITTED TO CHANGE THE VALUE OF THIS PARAMETER.
C1 FORMAT = I4
C1##
   1
C2 TITLE FOR CALCULATION   WILL APPEAR ON TOP OF GENERAL OUTPUT FILE
C2 FORMAT(1X,A68,I3)
C#################################################################### ###
 CO   NIGHT  WINTER  45-LATITUDE  SECOND RUN WITH NEW LOS              56
C3 LINE 2 CONTAINS THE VARIABLE IATMOS.
C3 THIS VARIABLE IS USED TO SELECT THE DESIRED MODEL ATMOSPHERE AND
C3 THE ATMOSPHERIC FILE NAME.
C3 FORMAT = I4,2X,A11
C3##  ###########
   7  SAT45WN.DAT
C4 LINE 3 CONTAINS THE EXO-ATMOSPHERIC TEMPERATURE AND
C4 A CONTROL PARAMETER WHICH SELECTS EITHER THE DAY(4) OR NIGHT(3)
C4 OPTION FOR THE MODEL ATMOSPHERE.
C4 FORMAT = E12.5,2X,A5
C4 #####E+##  #####
  .15000E+04  NIGHT
C5 NEMESIS CONTROL PARAMETERS
C5 WARNING: CHANGING THESE PARAMETERS WILL EFFECT THE ACCURACY
C5 OF THE MONTE CARLO SIMULATION.
C5 TOTAL NUMBER OF PHOTONS, MAXIMUM ORDER OF SCATTERING
C5 GLOBAL SUNSHINE AND EARTHSHINE PARAMETERS (1=YES , 0=NO)
C5 FORMAT=2X,6I,2X,6I,2x,I6,2X,I6
C5 #####  ######  ######  ######
   10000     200       0       1
C6 AFGL# FOR MOLECULE,LINKING FILE, STATE FILE, BAND FILE
C6 UP TO 5 RADIATORS H2O=1, CO2=2, O3=3, CO=5, NO=8
C6FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C6####  ###########  ###########  ###########
     5  COLINK.DAT   COSTAT.DAT   COBAND.DAT
C7 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C7####  ###########  ###########  ###########
     0  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C8 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C8 ###  ###########  ###########  ###########
     0  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C9 FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
```

```
C9 ###  ###########  ###########  ###########
     0  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C10FORMAT=2X,I4,2X,11A1,2X,11A1,2X,11A1
C10###  ###########  ###########  ###########
     0  NOLINK.DAT   NOSTAT.DAT   NOBAND.DAT
C11 SOLAR ZENITH ANGLE IN DEGREES. 0 FOR THE SUN OVERHEAD
C11( 0.0 WHEN THE SUN IS OVERHEAD)
C11FORMAT = E12.5
C#.#####E+##
  .15000E+02
C12NEXT 6 LINES CONTAIN LOS GEOMETRY INFORMATION
C12LINE 12 CONTAINS IPATH AND ICASE
C12FORMAT = I4,2X,I4
C12#  ####
   4     5
C13LINE 13 CONTAINS H1ALT, H1LONG AND H1LAT
C13FORMAT = 3(E12.7,2X)
C13#####E+##  .#######E+##  .#######E+##
.7000000E+02  .6200000E+02  .5000000E+02
C14LINE 14 CONTAINS H2ALT, H2LONG AND H2LAT
C14FORMAT = 3(E12.7,2X)
C14#####E+##  .#######E+##  .#######E+##
.2900000E+03  .6200000E+02  .7000000E+02
C15LINE 15 CONTAINS RANGE,BETA,A0
C15FORMAT = 3(E13.8,1x)
C15######E+## .########E+## .########E+##
 .6000000E+02  .1200000E+03  .0000000E+00
C16LINE 16 CONTAINS B0,HMIN,LEN
C16FORMAT = 2(E13.8,1x),I4
C16######E+## .########E+## ####
 .9000000E+02  .1500000E+03    0
C17Line 17 CONTAINS TIME,IDAY,ICASES
C17TIME IS GMT TIME (0. TO 24.)
C17IDAY IS FROM 1 TO 366
C17THESE OPTIONS ARE NOT USED IN SHARC-1
C17FORMAT = E12.7,2X,2I4
C17#####E+##  #### ###
.0000000E+00     6   1
C18SPECTRAL INFORMATION IN CM-1
C18 WMIN,WMAX,BINRES(RESOLUTION),IRELAY=1 FOR RELAYERING
C18FORMAT = 2X,3(E12.5,2X),I2,2X,E12.5
C18#.#####E+##  ##.#####E+##  ##.#####E+##  ##
    .19000E+04    .45000E+04    .10000E+01   1
C19 OUTPUT CONTROL PARAMETERS:
C19 1) MODEL ATMOSPHERE OUTPUT ==>1 FOR FULL LISTING
C19 2) ATMOSPHERIC MOLECULE IDENTIFICATION == >2 FOR TABLE
C19 3) MOLECULAR RADIATORS INFORMATION ==>2 FOR ECHO OF INPUTS
C19 4) NOT CURRENTLY USED
C19 5) SELECTED TRANSITIONS ==>1 FOR TRANSITIONS SELECTED
C19 6) MOLECULAR BAND INFORMATION ==>2 FOR ECHO OF BAND INFORMATION
C19 7) NEMESIS OUTPUT ==>1 NEMESIS ONLY ==2 FOR POST POPULATIONS
C19 8) FINAL STATE POPULATIONS ==>1 YES
```

```
C19 9) FINAL VIBRATIONAL TEMPERATURES ==>1 YES
C19 10)LOS OUTPUT ==>1 FOR COLUMN DENSITIES
C19 11)CURRENTLY NOT USED
C19 12)SPECTRAL RADIANCE OUTPUT ==>1 FOR RADIANCE OUTPUT IN GENERAL
C19    OUTPUT FILE  SPECTRAL INFORMATION IS ALWAYS PLACED IN SPEC.OUT
C19 FORMAT = 12(2X,I2)
C  1   2   3   4   5   6   7   8   9  10  11  12
C ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##
   1   0   0   0   1   0   0   1   1   1   0   0
C20 SAVED POPULATIONS FILE NAME AND ISAVE
C20 WHEN ISAVE = 0 POPULATIONS ARE SAVED
C20 ISAVE = 1 SAVED POPULATIONS ARE USED FOR CALCULATION
C20 FORMAT=(2X,A20,2X,I4)
C2####################  ####
  CO45WIN.DAT             1
```

APPENDIX F

TEST CASE -- OUTPUTS

The general SHARC output file is called SHARC.OUT. This appendix includes the output for the input files given in Appendix E. The output should be printed on 132 column paper, or at 17 characters per inch on 8.5 inch paper.

Output file for first test case.

```
    SSSSSS    HH    HH     AAAAAA      RRRRRR        CCCCCC
  SS         HH    HH    AA     AA    RR     RR     CC
 SS         HH    HH    AA     AA    RR     RR     CC
SSSSS      HHHHHHHH    AAAAAAAA     RRRRRRR       CC
    SS    HH    HH    AA     AA    RR    RR      CC
   SS    HH    HH    AA     AA    RR      RR    CC
SSSSSS  HH    HH    AA     AA    RR      RR    CCCCCC
```

STRATEGIC HIGH-ALTITUDE RADIANCE CODE

VERSION 1.0

********** CO, CO2, NO, H2O, O3 DAYTIME 1976 STANDARD ATMOSPHERE **********

Fri Feb 3 15:59:00 1989

ATMOSPHERIC PROFILE

ATMOSPHERE FILE NAME: SAT1976.DAT
NUMBER OF LAYERS: 60
EXOATMOSPHERIC TEMPERATURE(K): 1000.0
DAY-NIGHT PARAMETER: DAY

ALT(KM)	TEMP(K)	TOTAL NUMBER DENSITY(MOLEC/CM3)									
		O2	O	CH4	CO2	H2O	NO	N2O	CO	N2	O3
60.0	247.1	.135E+16	.120E+11	.603E+14	.203E+13	.312E+11	.900E+08	.645E+11	.904E+09	.504E+16	.733E+10
62.0	241.6	.105E+16	.133E+11	.469E+14	.158E+13	.238E+11	.720E+08	.502E+11	.100E+10	.392E+16	.440E+10
64.0	236.1	.812E+15	.147E+11	.362E+14	.122E+13	.181E+11	.580E+08	.388E+11	.109E+10	.303E+16	.240E+10
66.0	230.6	.624E+15	.163E+11	.278E+14	.936E+12	.134E+11	.460E+08	.298E+11	.119E+10	.233E+16	.110E+10
68.0	225.1	.477E+15	.181E+11	.213E+14	.715E+12	.101E+11	.370E+08	.228E+11	.123E+10	.178E+16	.520E+09
70.0	219.6	.362E+15	.200E+11	.161E+14	.542E+12	.734E+10	.290E+08	.173E+11	.121E+10	.135E+16	.200E+09
72.0	214.3	.273E+15	.249E+11	.122E+14	.408E+12	.531E+10	.230E+08	.130E+11	.125E+10	.102E+16	.900E+08
74.0	210.4	.203E+15	.310E+11	.904E+13	.304E+12	.371E+10	.180E+08	.968E+10	.126E+10	.755E+15	.460E+08
76.0	206.4	.150E+15	.387E+11	.668E+13	.225E+12	.256E+10	.140E+08	.716E+10	.122E+10	.559E+15	.270E+08
78.0	202.5	.110E+15	.482E+11	.492E+13	.165E+12	.175E+10	.115E+08	.526E+10	.116E+10	.411E+15	.190E+08
80.0	198.6	.807E+14	.600E+11	.360E+13	.121E+12	.116E+10	.960E+07	.385E+10	.116E+10	.301E+15	.180E+08
82.0	194.7	.586E+14	.676E+11	.261E+13	.879E+11	.723E+09	.870E+07	.280E+10	.118E+10	.219E+15	.220E+08
84.0	190.8	.424E+14	.763E+11	.189E+13	.635E+11	.438E+09	.820E+07	.202E+10	.111E+10	.158E+15	.380E+08
86.0	186.9	.304E+14	.860E+11	.136E+13	.456E+11	.266E+09	.870E+07	.145E+10	.113E+10	.113E+15	.450E+08
88.0	186.9	.213E+14	.151E+12	.950E+12	.319E+11	.153E+09	.105E+08	.102E+10	.107E+10	.794E+14	.450E+08
90.0	186.9	.149E+14	.244E+12	.666E+12	.224E+11	.891E+08	.140E+08	.713E+09	.107E+10	.557E+14	.380E+08
92.0	187.0	.105E+14	.343E+12	.466E+12	.157E+11	.479E+08	.180E+08	.499E+09	.105E+10	.390E+14	.280E+08
94.0	187.7	.731E+13	.416E+12	.326E+12	.110E+11	.262E+08	.230E+08	.349E+09	.977E+09	.273E+14	.200E+08
96.0	189.3	.510E+13	.447E+12	.227E+12	.764E+10	.132E+08	.300E+08	.243E+09	.876E+09	.190E+14	.140E+08
98.0	191.7	.356E+13	.448E+12	.159E+12	.533E+10	.566E+07	.360E+08	.170E+09	.781E+09	.133E+14	.900E+07
100.0	195.1	.248E+13	.430E+12	.111E+12	.372E+10	.247E+07	.400E+08	.118E+09	.711E+09	.925E+13	.500E+07
102.0	199.5	.173E+13	.401E+12	.773E+11	.260E+10	.138E+07	.420E+08	.828E+08	.580E+09	.647E+13	.350E+07
104.0	205.3	.122E+13	.362E+12	.542E+11	.182E+10	.870E+06	.440E+08	.580E+08	.464E+09	.453E+13	.245E+07
106.0	212.9	.855E+12	.319E+12	.381E+11	.128E+10	.561E+06	.450E+08	.408E+08	.367E+09	.319E+13	.172E+07
108.0	223.3	.602E+12	.275E+12	.268E+11	.902E+09	.371E+06	.440E+08	.287E+08	.276E+09	.224E+13	.121E+07
110.0	240.0	.421E+12	.230E+12	.188E+11	.631E+09	.251E+06	.430E+08	.201E+08	.201E+09	.157E+13	.848E+06
112.0	264.0	.286E+12	.189E+12	.119E+11	.385E+09	.194E+06	.420E+08	.139E+08	.142E+09	.111E+13	.499E+06
114.0	288.0	.202E+12	.156E+12	.783E+10	.246E+09	.153E+06	.400E+08	.996E+07	.103E+09	.805E+12	.308E+06
116.0	312.0	.146E+12	.130E+12	.534E+10	.162E+09	.123E+06	.390E+08	.732E+07	.770E+08	.601E+12	.198E+06
118.0	336.0	.108E+12	.110E+12	.375E+10	.111E+09	.101E+06	.370E+08	.551E+07	.587E+08	.458E+12	.131E+06
120.0	360.0	.820E+11	.928E+11	.269E+10	.775E+08	.838E+05	.360E+08	.423E+07	.456E+08	.356E+12	.893E+05
122.0	383.5	.633E+11	.799E+11	.198E+10	.556E+08	.704E+05	.348E+08	.330E+07	.361E+08	.282E+12	.625E+05
124.0	406.2	.497E+11	.688E+11	.149E+10	.407E+08	.600E+05	.336E+08	.262E+07	.290E+08	.226E+12	.448E+05
126.0	428.0	.396E+11	.598E+11	.113E+10	.304E+08	.516E+05	.324E+08	.211E+07	.236E+08	.185E+12	.327E+05
128.0	449.0	.320E+11	.526E+11	.880E+09	.231E+08	.448E+05	.312E+08	.173E+07	.195E+08	.152E+12	.244E+05
130.0	469.3	.262E+11	.462E+11	.691E+09	.178E+08	.392E+05	.300E+08	.142E+07	.162E+08	.127E+12	.184E+05
132.0	488.4	.216E+11	.413E+11	.550E+09	.139E+08	.346E+05	.287E+08	.119E+07	.137E+08	.107E+12	.141E+05
134.0	507.5	.180E+11	.370E+11	.441E+09	.109E+08	.307E+05	.274E+08	.997E+06	.116E+08	.904E+11	.109E+05
136.0	525.2	.151E+11	.333E+11	.358E+09	.871E+07	.274E+05	.262E+08	.845E+06	.990E+07	.773E+11	.853E+04
138.0	542.9	.128E+11	.302E+11	.292E+09	.700E+07	.246E+05	.251E+08	.720E+06	.851E+07	.664E+11	.673E+04
140.0	559.3	.109E+11	.273E+11	.241E+09	.567E+07	.221E+05	.240E+08	.618E+06	.736E+07	.575E+11	.537E+04
142.0	575.7	.929E+10	.250E+11	.200E+09	.462E+07	.200E+05	.228E+08	.533E+06	.640E+07	.499E+11	.431E+04
144.0	591.0	.800E+10	.228E+11	.167E+09	.380E+07	.182E+05	.216E+08	.462E+06	.559E+07	.437E+11	.349E+04

146.0	606.2	.691E+10	.209E+11	.140E+09	.314E+07	.166E+05	.205E+08	.402E+06	.491E+07	.383E+11	.284
148.0	620.3	.601E+10	.193E+11	.118E+09	.261E+07	.152E+05	.195E+08	.352E+06	.433E+07	.338E+11	.232
150.0	634.4	.524E+10	178E+11	.999E+08	.218E+07	.139E+05	.185E+08	.309E+06	.383E+07	.299E+11	.191
160.0	696.3	.278E+10	.124E+11	.464E+08	.944E+06	.934E+04	.135E+08	.170E+06	.217E+07	.170E+11	.775
170.0	747.6	.158E+10	.900E+10	.233E+08	.444E+06	.658E+04	.881E+07	.993E+05	.131E+07	.102E+11	.343
180.0	790.1	.937E+09	.675E+10	.123E+08	.222E+06	.479E+04	.575E+07	.608E+05	.826E+06	644E+10	.162
190.0	825.3	.577E+09	.518E+10	.680E+07	.116E+06	.358E+04	.368E+07	.385E+05	.537E+06	.419E+10	.799
200.0	854.6	.365E+09	.405E+10	.388E+07	.626E+05	.273E+04	.235E+07	.250E+05	.359E+06	.280E+10	.410
210.0	876.8	.237E+09	.324E+10	.227E+07	.348E+05	.211E+04	.160E+07	.166E+05	.244E+06	.191E+10	.216
220.0	899.0	.155E+09	.258E+10	.135E+07	.196E+05	.165E+04	.109E+07	.112E+05	.168E+06	.131E+10	.116
230.0	907.4	.104E+09	.209E+10	.821E+06	.114E+05	.131E+04	.743E+06	.768E+04	.119E+06	.926E+09	.642
240.0	915.8	.703E+08	.170E+10	.504E+06	.665E+04	105E+04	.506E+06	.530E+04	.839E+05	.655E+09	.357
250.0	933.4	.472E+08	.139E+10	.308E+06	388E+04	.829E+03	.345E+06	.365E+04	.592E+05	.462E+09	.199
260.0	951.0	.320E+08	.115E+10	.191E+06	.229E+04	.661E+03	.244E+06	.253E+04	.420E+05	.328E+09	.112
270.0	957.2	.221E+08	.947E+09	.120E+06	.138E+04	.535E+03	.173E+06	.179E+04	.303E+05	.237E+09	.645
280.0	963.5	.153E+08	.784E+09	.762E+05	.834E+03	.434E+03	.123E+06	.127E+04	.220E+05	.172E+09	.373
290.0	969.8	.106E+08	.653E+09	.484E+05	.507E+03	.352E+03	.868E+05	.901E+03	.160E+05	.125E+09	.217
300.0	976.0	.743E+07	.543E+09	.309E+05	.310E+03	.287E+03	.615E+05	.642E+03	.116E+05	.909E+08	.127

H2O RADIATIVE PROPERTIES

STATE	ENERGY(CM-1)	DEGENERACY
H2O(000)	.000	1.
H2O(010)	1594.750	1.
H2O(020)	3151.630	1.
H2O(100)	3657.053	1.
H2O(001)	3755.930	1.
H2O(030)	4666.793	1.
H2O(110)	5234.977	1.
H2O(011)	5331.269	1.

TRANSITION	FREQUENCY(CM-1)	ESHINE T(K)	RADIANCE
H2O(010) -H2O(000)	1594.750	260.0	Y
H2O(020) -H2O(000)	3151.630	270.0	Y
H2O(100) -H2O(000)	3657.053	260.0	Y
H2O(001) -H2O(000)	3755.930	260.0	Y
H2O(030) -H2O(000)	4666.793	280.0	Y
H2O(110) -H2O(000)	5234.977	280.0	Y
H2O(011) -H2O(000)	5331.269	270.0	Y
H2O(020) -H2O(010)	1556.880	230.0	Y
H2O(100) -H2O(010)	2062.303	250.0	Y
H2O(001) -H2O(010)	2161.180	250.0	Y
H2O(030) -H2O(010)	3072.043	280.0	Y
H2O(110) -H2O(010)	3640.227	250.0	Y
H2O(011) -H2O(010)	3736.519	250.0	Y
H2O(030) -H2O(020)	1515.163	240.0	Y

EXCITED STATE NUMBER DENSITIES(MOLEC/CM3)

ALT(KM)	H2O(000)	H2O(010)	H2O(020)	H2O(100)	H2O(001)	H2O(030)	H2O(110)	H2O(011)
61.0	.275E+11	.231E+07	.628E+04	.514E+03	.311E+04	.166E+01	.848E-01	.308E+00
63.0	.210E+11	.143E+07	.619E+04	.485E+03	.313E+04	.139E+01	.698E-01	.249E+00
65.0	.158E+11	.862E+06	.600E+04	.451E+03	.307E+04	.114E+01	.571E-01	.197E+00
67.0	.117E+11	.515E+06	.573E+04	.415E+03	.297E+04	.936E+00	.470E-01	.155E+00
69.0	.870E+10	.307E+06	.541E+04	.380E+03	.284E+04	.768E+00	.393E-01	.122E+00
71.0	.633E+10	.182E+06	.498E+04	.342E+03	.265E+04	.627E+00	.330E-01	.949E-01
73.0	.451E+10	.111E+06	.445E+04	.304E+03	.243E+04	.520E+00	.283E-01	.758E-01
75.0	.314E+10	.706E+05	.382E+04	.265E+03	.216E+04	.432E+00	.246E-01	.617E-01
77.0	.216E+10	.462E+05	.318E+04	.228E+03	.189E+04	.358E+00	.215E-01	.506E-01
79.0	.146E+10	.311E+05	.252E+04	.193E+03	.159E+04	.292E+00	.187E-01	.416E-01
81.0	.939E+09	.211E+05	.185E+04	.156E+03	.126E+04	.227E+00	.158E-01	.336E-01
83.0	.581E+09	.143E+05	.125E+04	.122E+03	.942E+03	.167E+00	.130E-01	.264E-01
85.0	.352E+09	.976E+04	.789E+03	.940E+02	.674E+03	.119E+00	.106E-01	.207E-01
87.0	.209E+09	.672E+04	.465E+03	.728E+02	.464E+03	.804E-01	.871E-02	.161E-01
89.0	.121E+09	.451E+04	.253E+03	.558E+02	.303E+03	.511E-01	.706E-02	.120E-01
91.0	.685E+08	.290E+04	.129E+03	.420E+02	.189E+03	.305E-01	.558E-02	.846E-02
93.0	.370E+08	.174E+04	.602E+02	.300E+02	.110E+03	.168E-01	.417E-02	.547E-02
95.0	.197E+08	.101E+04	.269E+02	.209E+02	.618E+02	.888E-02	.303E-02	.335E-02
97.0	.942E+07	.516E+03	.106E+02	.129E+02	.308E+02	.416E-02	.194E-02	.179E-02
99.0	.406E+07	.234E+03	.369E+01	.699E+01	.137E+02	.173E-02	.109E-02	.837E-03
101.0	.192E+07	.115E+03	.140E+01	.404E+01	.662E+01	.790E-03	.651E-03	.421E-03
103.0	.113E+07	.689E+02	.651E+00	.280E+01	.393E+01	.445E-03	.465E-03	.257E-03
105.0	.716E+06	.447E+02	.328E+00	.204E+01	.253E+01	.272E-03	.350E-03	.169E-03
107.0	.466E+06	.295E+02	.169E+00	.148E+01	.166E+01	.172E-03	.261E-03	.113E-03
109.0	.311E+06	.200E+02	.901E-01	.107E+01	.111E+01	.111E-03	.195E-03	.767E-04
111.0	.223E+06	.146E+02	.518E-01	.818E+00	.799E+00	.778E-04	.155E-03	.562E-04
113.0	.174E+06	.116E+02	.333E-01	.668E+00	.625E+00	.596E-04	.132E-03	.450E-04
115.0	.138E+06	.951E+01	.227E-01	.549E+00	.499E+00	.469E-04	.114E-03	.369E-04
117.0	.112E+06	.789E+01	.162E-01	.455E+00	.405E+00	.377E-04	.984E-04	.307E-04
119.0	.924E+05	.666E+01	.120E-01	.381E+00	.334E+00	.309E-04	.859E-04	.260E-04
121.0	.771E+05	.568E+01	.923E-02	.321E+00	.279E+00	.256E-04	.754E-04	.222E-04
123.0	.652E+05	.491E+01	.731E-02	.274E+00	.236E+00	.216E-04	.666E-04	.192E-04
125.0	.558E+05	.427E+01	.594E-02	.236E+00	.202E+00	.184E-04	.589E-04	.167E-04
127.0	.482E+05	.375E+01	.492E-02	.205E+00	.174E+00	.159E-04	.524E-04	.147E-04
129.0	.420E+05	.331E+01	.415E-02	.179E+00	.152E+00	.138E-04	.468E-04	.130E-04
131.0	.369E+05	.293E+01	.354E-02	.158E+00	.134E+00	.121E-04	.418E-04	.115E-04
133.0	.326E+05	.261E+01	.306E-02	.140E+00	.118E+00	.107E-04	.375E-04	.103E-04
135.0	.290E+05	.233E+01	.267E-02	.125E+00	.105E+00	.954E-05	.337E-04	.916E-05
137.0	.260E+05	.209E+01	.236E-02	.112E+00	.940E-01	.853E-05	.303E-04	.821E-05
139.0	.234E+05	.189E+01	.209E-02	.101E+00	.845E-01	.766E-05	.274E-04	.743E-05
141.0	.211E+05	.170E+01	.187E-02	.910E-01	.763E-01	.691E-05	.247E-04	.667E-05
143.0	.191E+05	.155E+01	.168E-02	.826E-01	.692E-01	.626E-05	.224E-04	.607E-05
145.0	.174E+05	.140E+01	.151E-02	.752E-01	.629E-01	.569E-05	.203E-04	.549E-05
147.0	.159E+05	.127E+01	.137E-02	.686E-01	.575E-01	.519E-05	.185E-04	.499E-05
149.0	.145E+05	.117E+01	.125E-02	.629E-01	.526E-01	.475E-05	.169E-04	.459E-05
155.0	.116E+05	.923E+00	.984E-03	.503E-01	.421E-01	.379E-05	.133E-04	.362E-05
165.0	.796E+04	.613E+00	.663E-03	.345E-01	.288E-01	.259E-05	.872E-05	.240E-05
175.0	.569E+04	.424E+00	.469E-03	.247E-01	.206E-01	.185E-05	.592E-05	.166E-05
185.0	.419E+04	.302E+00	.343E-03	.182E-01	.152E-01	.136E-05	.416E-05	.118E-05

195.0	.315E+04	.221E+00	.257E-03	.137E-01	.114E-01	.102E-05	.301E-05	.864E-06
205.0	.242E+04	.168E+00	.196E-03	.105E-01	.875E-02	.783E-06	.223E-05	.653E-06
215.0	.188E+04	.128E+00	.152E-03	.816E-02	.680E-02	.608E-06	.169E-05	.500E-06
225.0	.148E+04	.978E-01	.120E-03	.642E-02	.535E-02	.478E-06	.129E-05	.381E-06
235 0	.118E+04	.786E-01	.952E-04	.512E-02	.426E-02	.381E-06	.102E-05	.305E-06
245.0	.937E+03	.640E-01	.758E-04	.407E-02	.340E-02	.303E-06	.807E-06	.248E-06
255.0	.745E+03	.483E-01	.601E-04	.324E-02	.270E-02	.240E-06	.628E-06	.188E-06
265 0	.598E+03	387E-01	.482E-04	260E-02	.216E-02	.193E-06	.500E-06	.151E-06
275.0	.484E+03	.294E-01	.390E-04	210E-02	.175E-02	.156E-06	.396E-06	.115E-06
285.0	.393E+03	.233E-01	.316E-04	.171E-02	.142E-02	.126E-06	.318E-06	.917E-07
295.0	.320E+03	.189E-01	.257E-04	.139E-02	.116E-02	.103E-06	.258E-06	.746E-07

VIBRATIONAL TEMPERATURES(K)

ALT(KM)	KINETIC	H2O(010)	H2O(020)	H2O(100)	H2O(001)	H2O(030)	H2O(110)	H2O(011)
61.0	244.3	244.5	296.5	295.7	337.8	285.4	284.2	304.2
63.0	238.8	239.1	301.6	299.3	343.8	286.5	285.0	304.9
65.0	233.3	233.8	306.8	302.9	349.8	287.6	285.9	305.6
67.0	227.8	228.7	312.0	306.7	355.7	288.8	287.0	306.2
69.0	222.3	223.8	317.3	310.5	361.8	290.0	288.3	306.9
71.0	216.9	219.4	322.6	314.4	368.0	291.5	289.9	307.8
73.0	212.3	216.3	327.9	318.6	374.4	293.4	292.0	309.2
75.0	208.4	214.4	333.0	323.1	380.9	295.7	294.5	311.2
77.0	204.5	213.4	337.7	327.6	387.4	298.2	297.3	313.4
79.0	200.6	213.4	341.8	332.2	393.7	300.7	300.3	316.0
81.0	196.7	214.3	345.2	337.1	399.7	303.2	303.6	318.9
83.0	192.7	216.2	347.5	342.2	405.3	305.7	307.1	322.1
85.0	198.8	218.7	348.5	347.6	410.5	307.8	310.9	325.6
87.0	186.9	221.8	348.4	353.8	415.1	309.7	315.1	329.4
89.0	186.9	225.0	346.8	360.7	419.0	311.1	319.7	333.0
91.0	186.9	227.9	343.9	367.8	422.2	311.8	324.2	336.2
93.0	187.4	230.3	340.2	375.2	424.6	312.1	328.8	338.9
95.0	188.5	232.3	335.8	382.6	426.5	312.0	333.3	341.0
97.0	190.5	233.8	331.0	389.7	427.9	311.7	337.7	342.7
99.0	193.4	235.0	326.0	396.4	428.9	311.2	341.7	343.9
101.0	197.3	235.9	320.8	402.5	429.6	310.7	345.4	344.8
103.0	202.4	236.5	315.7	407.7	430.1	310.1	348.6	345.5
105.0	209.1	237.0	310.7	412.1	430.5	309.6	351.3	346.0
107.0	218.1	237.4	305.8	415.6	430.7	309.1	353.6	346.4
109.0	231.6	237.7	301.2	418.3	430.9	308.7	355.5	346.7
111.0	252.0	238.2	296.9	420.5	431.0	308.4	357.2	347.1
113.0	276.0	238.8	293.2	422.0	431.1	308.1	358.7	347.5
115.0	300.0	239.4	290.2	423.1	431.2	307.9	360.1	348.0
117.0	324.0	240.0	287.9	423.8	431.2	307.8	361.2	348.4
119.0	348.0	240.6	286.0	424.4	431.2	307.7	362.2	348.8
121.0	371.8	241.1	284.5	424.8	431.3	307.7	363.1	349.2
123.0	394.9	241.7	283.3	425.0	431.3	307.6	363.8	349.5
125.0	417.1	242.1	282.4	425.3	431.3	307.6	364.4	349.8
127.0	438.5	242.5	281.7	425.4	431.3	307.6	364.9	350.1
129.0	459.2	242.8	281.1	425.6	431.3	307.5	365.4	350.3
131.0	478.8	243.0	280.6	425.7	431.3	307.5	365.7	350.4
133.0	497.9	243.2	280.2	425.7	431.3	307.5	365.9	350.6
135.0	516.3	243.3	279.9	425.8	431.3	307.5	366.1	350.6
137.0	534.0	243.4	279.6	425.9	431.3	307.5	366.2	350.7
139.0	551.1	243.6	279.4	425.9	431.3	307.5	366.3	350.8
141.0	567.5	243.4	279.2	425.9	431.3	307.5	366.3	350.7
143.0	583.3	243.5	279.1	426.0	431.3	307.5	366.3	350.7
145.0	598.6	243.4	278.9	426.0	431.3	307.4	366.2	350.7
147.0	613.2	243.2	278.8	426.0	431.3	307.4	366.1	350.6
149.0	627.3	243.4	278.7	426.0	431.3	307.4	366.1	350.6
155.0	665.3	243.0	278.5	426.1	431.3	307.4	365.9	350.4
165.0	721.9	242.2	278.2	426.1	431.3	307.4	365.1	349.9
175.0	768.8	241.4	278.0	426.1	431.3	307.3	364.2	349.4
185.0	807.7	240.6	277.9	426.2	431.3	307.3	363.3	348.8

195.0	839.9	239.9	277.8	426.2	431.3	307.3	362.6	348.4
205.0	865.7	239.6	277.8	426.2	431.3	307.3	362.1	348.1
215.0	887.9	239.3	277.7	426.2	431.3	307.3	361.6	347.9
225.0	903.2	238.4	277.7	426.2	431.3	307.3	361.1	347.4
235.0	911.6	238.7	277.7	426.2	431.3	307.3	360.9	347.5
245.0	924.6	239.2	277.7	426.2	431.4	307.3	360.9	347.8
255.0	942.2	238.0	277.6	426.2	431.3	307.2	360.5	347.1
265.0	954.1	237.9	277.6	426.2	431.3	307.2	360.4	347.1
275.0	960.4	236.3	277.6	426.2	431.3	307.2	360.0	346.2
285.0	966.6	235.7	277.6	426.2	431.3	307.2	359.8	345.9
295.0	972.9	235.7	277.6	426.2	431.4	307.2	359.8	345.9

CO2 RADIATIVE PROPERTIES

STATE	ENERGY(CM-1)	DEGENERACY
CO2(00001)	.000	1.
CO2(01101)	667.380	2.
CO2(10002)	1285.409	1
CO2(02201)	1335.132	2.
CO2(10001)	1388.185	1.
CO2(11102)	1932.470	2.
CO2(03301)	2003.246	2.
CO2(11101)	2076.856	2.
CO2(00011)	2349.143	1.
CO2(20003)	2548.366	1.
CO2(20002)	2671.143	1.
CO2(20001)	2797.135	1.
CO2(01111)	3004.012	2.
CO2(10012)	3612.842	1.
CO2(02211)	3659.273	2.
CO2(10011)	3714.783	1.
CO2(20013)	4853.623	1.
CO2(04411)	4908.396	2.
CO2(20012)	4977.834	1
CO2(20011)	5099.660	1.

TRANSITION	FREQUENCY(CM-1)	ESHINE T(K)	RADIANCE
CO2(01101)-CO2(00001)	667.380	260.0	Y
CO2(11102)-CO2(00001)	1932.470	240.0	Y
CO2(11101)-CO2(00001)	2076.856	240.0	Y
CO2(00011)-CO2(00001)	2349.143	250.0	Y
CO2(10012)-CO2(00001)	3612.842	260.0	Y
CO2(10011)-CO2(00001)	3714.783	260.0	Y
CO2(20013)-CO2(00001)	4853.623	230.0	Y
CO2(20012)-CO2(00001)	4977.834	240.0	Y
CO2(20011)-CO2(00001)	5099.660	240.0	Y
CO2(10002)-CO2(01101)	618.029	250.0	Y
CO2(02201)-CO2(01101)	667.752	260.0	Y
CO2(10001)-CO2(01101)	720.805	260.0	Y
CO2(01111)-CO2(01101)	2336.632	260.0	Y
CO2(11102)-CO2(10002)	647.061	250.0	Y
CO2(11101)-CO2(10002)	791.447	230.0	Y
CO2(00011)-CO2(10002)	1063.734	230.0	Y
CO2(10012)-CO2(10002)	2327.433	250.0	Y
CO2(20013)-CO2(10002)	3568.214	250.0	Y
CO2(20012)-CO2(10002)	3692.425	250.0	Y
CO2(11102)-CO2(02201)	597.338	260.0	Y
CO2(03301)-CO2(02201)	668.114	250.0	Y
CO2(11101)-CO2(02201)	741.724	230.0	Y
CO2(02211)-CO2(02201)	2324.141	250.0	Y
CO2(11102)-CO2(10001)	544.285	230.0	Y
CO2(11101)-CO2(10001)	688.671	250.0	Y

CO_2(00011)-CO_2(10001)	960.958	230.0	Y
CO_2(10011)-CO_2(10001)	2326.598	250.0	Y
CO_2(20012)-CO_2(10001)	3589.649	250.0	Y
CO_2(20011)-CO_2(10001)	3711.475	250.0	Y

EXCITED STATE NUMBER DENSITIES(MOLEC/CM3)

ALT(KM)	CO2(00001)	CO2(01101)	CO2(10002)	CO2(02201)	CO2(10001)	CO2(11102)	CO2(03301)	CO2(11101)	CO2(00011)	CO2(20003)
	CO2(20002)	CO2(20001)	CO2(01111)	CO2(10012)	CO2(02211)	CO2(10011)	CO2(20013)	CO2(04411)	CO2(20012)	CO2(20011)
61.0	.173E+13	.676E+11	.903E+09	.135E+10	.493E+09	.407E+08	.268E+08	.174E+08	.128E+07	.100E+07
	.741E+06	.569E+06	.771E+04	.617E+04	.450E+04	.340E+04	.115E+04	.182E+04	.120E+04	.111E+04
63.0	.135E+13	.481E+11	.576E+09	.853E+09	.310E+09	.243E+08	.158E+08	.102E+08	.799E+06	.804E+06
	.665E+06	.559E+06	.572E+04	.692E+04	.444E+04	.377E+04	.113E+04	.179E+04	.116E+04	.109E+04
65.0	.104E+13	.341E+11	.366E+09	.539E+09	.194E+09	.146E+08	.942E+07	.600E+07	.548E+06	.723E+06
	.649E+06	.581E+06	.642E+04	.789E+04	.433E+04	.424E+04	.110E+04	.175E+04	.113E+04	.107E+04
67.0	.801E+12	.238E+11	.228E+09	.333E+09	.119E+09	.876E+07	.558E+07	.352E+07	.526E+06	.707E+06
	.667E+06	.622E+06	.803E+04	.914E+04	.421E+04	.485E+04	.108E+04	.171E+04	.109E+04	.105E+04
69.0	.612E+12	.162E+11	.135E+09	.196E+09	.694E+08	.515E+07	.325E+07	.203E+07	.515E+06	.728E+06
	.704E+06	.675E+06	.985E+04	.107E+05	.408E+04	.559E+04	.105E+04	.167E+04	.105E+04	.102E+04
71.0	.464E+12	.112E+11	.800E+08	.115E+09	.405E+08	.313E+07	.194E+07	.120E+07	.488E+06	.772E+06
	.754E+06	.736E+06	.133E+05	.126E+05	.399E+04	.649E+04	.102E+04	.162E+04	.101E+04	.995E+03
73.0	.349E+12	.726E+10	.464E+08	.661E+08	.231E+08	.202E+07	.124E+07	.759E+06	.978E+06	.815E+06
	.794E+06	.784E+06	.155E+05	.147E+05	.386E+04	.751E+04	.990E+03	.158E+04	.976E+03	.968E+03
75.0	.259E+12	.544E+10	.312E+08	.441E+08	.153E+08	.151E+07	.916E+06	.557E+06	.132E+07	.841E+06
	.815E+06	.810E+06	.189E+05	.169E+05	.367E+04	.851E+04	.965E+03	.153E+04	.942E+03	.939E+03
77.0	.192E+12	.338E+10	.178E+08	.249E+08	.864E+07	.855E+06	.513E+06	.310E+06	.565E+06	.845E+06
	.810E+06	.813E+06	.172E+05	.183E+05	.323E+04	.917E+04	.939E+03	.148E+04	.904E+03	.908E+03
79.0	.141E+12	.227E+10	.116E+08	.161E+08	.557E+07	.650E+06	.385E+06	.231E+06	.104E+07	.813E+06
	.768E+06	.776E+06	.164E+05	.188E+05	.266E+04	.931E+04	.911E+03	.143E+04	.862E+03	.872E+03
81.0	.103E+12	.144E+10	.748E+07	.102E+08	.352E+07	.498E+06	.290E+06	.173E+06	.159E+07	.744E+06
	.688E+06	.701E+06	.131E+05	.180E+05	.201E+04	.883E+04	.880E+03	.136E+04	.815E+03	.831E+03
83.0	.748E+11	.891E+09	.479E+07	.640E+07	.222E+07	.319E+06	.183E+06	.109E+06	.124E+07	.643E+06
	.579E+06	.596E+06	.928E+04	.160E+05	.139E+04	.784E+04	.843E+03	.129E+04	.760E+03	.782E+03
85.0	.539E+11	.645E+09	.346E+07	.452E+07	.158E+07	.222E+06	.124E+06	.738E+05	.995E+06	.513E+06
	.447E+06	.464E+06	.726E+04	.134E+05	.890E+03	.654E+04	.801E+03	.120E+04	.698E+03	.725E+03
87.0	.383E+11	.427E+09	.234E+07	.298E+07	.106E+07	.137E+06	.751E+05	.451E+05	.646E+06	.303E+06
	.253E+06	.266E+06	.502E+04	.106E+05	.532E+03	.523E+04	.756E+03	.110E+04	.631E+03	.664E+03
89.0	.269E+11	.279E+09	.157E+07	.193E+07	.713E+06	.842E+05	.450E+05	.277E+05	.473E+06	.138E+06
	.109E+06	.116E+06	.334E+04	.802E+04	.299E+03	.403E+04	.708E+03	.982E+03	.557E+03	.595E+03
91.0	.188E+11	.188E+09	.109E+07	.128E+07	.494E+06	.540E+05	.278E+05	.178E+05	.404E+06	.635E+05
	.466E+05	.505E+05	.228E+04	.589E+04	.164E+03	.305E+04	.649E+03	.857E+03	.477E+03	.518E+03
93.0	.132E+11	.127E+09	.762E+06	.842E+06	.346E+06	.345E+05	.169E+05	.114E+05	.284E+06	.315E+05
	.214E+05	.236E+05	.155E+04	.423E+04	.882E+02	.228E+04	.580E+03	.726E+03	.396E+03	.437E+03
95.0	.921E+10	.873E+08	.546E+06	.566E+06	.249E+06	.233E+05	.106E+05	.773E+04	.192E+06	.168E+05
	.106E+05	.119E+05	.106E+04	.299E+04	.471E+02	.169E+04	.504E+03	.596E+03	.318E+03	.357E+03
97.0	.642E+10	.613E+08	.402E+06	.390E+06	.185E+06	.167E+05	.702E+04	.561E+04	.145E+06	.945E+04
	.555E+04	.629E+04	.746E+03	.208E+04	.253E+02	.125E+04	.423E+03	.475E+03	.249E+03	.283E+03
99.0	.448E+10	.422E+08	.295E+06	.266E+06	.138E+06	.122E+05	.465E+04	.415E+04	.103E+06	.538E+04
	.296E+04	.339E+04	.513E+03	.143E+04	.137E+02	.921E+03	.344E+03	.368E+03	.190E+03	.218E+03
101.0	.313E+10	.299E+08	.221E+06	.187E+06	.105E+06	.921E+04	.318E+04	.321E+04	.703E+05	.306E+04
	.159E+04	.184E+04	.362E+03	.983E+03	.767E+01	.677E+03	.271E+03	.278E+03	.141E+03	.164E+03
103.0	.219E+10	.214E+08	.167E+06	.134E+06	.804E+05	.713E+04	.224E+04	.255E+04	.480E+05	.174E+04
	.865E+03	.101E+04	.258E+03	.673E+03	.443E+01	.496E+03	.208E+03	.207E+03	.104E+03	.122E+03
105.0	.154E+10	.155E+08	.127E+06	.978E+05	.626E+05	.563E+04	.164E+04	.208E+04	.337E+05	.988E+03
	.476E+03	.555E+03	.186E+03	.462E+03	.268E+01	.362E+03	.156E+03	.151E+03	.756E+02	.892E+02
107.0	.108E+10	.114E+08	.974E+05	.743E+05	.496E+05	.454E+04	.125E+04	.174E+04	.236E+05	.563E+03
	.265E+03	.308E+03	.138E+03	.319E+03	.172E+01	.264E+03	.116E+03	.109E+03	.546E+02	.647E+02

109.0	.758E+09	.873E+07	.767E+05	.603E+05	.406E+05	.382E+04	.104E+04	.154E+04	.163E+05	.320E+03
	.149E+03	.171E+03	.105E+03	.220E+03	.120E+01	.190E+03	.842E+02	.782E+02	.391E+02	.465E+02
111.0	.501E+09	.659E+07	.596E+05	.506E+05	.332E+05	.323E+04	.921E+03	.139E+04	.105E+05	.176E+03
	.818E+02	.900E+02	.791E+02	.144E+03	.897E+00	.129E+03	.573E+02	.522E+02	.264E+02	.313E+02
113.0	.311E+09	.469E+07	.438E+05	.405E+05	.255E+05	.259E+04	.785E+03	.119E+04	.631E+04	.986E+02
	.468E+02	.474E+02	.562E+02	.884E+02	.666E+00	.813E+02	.362E+02	.325E+02	.166E+02	.197E+02
115.0	.200E+09	.337E+07	.325E+05	.321E+05	.196E+05	.206E+04	.659E+03	.995E+03	.398E+04	.636E+02
	.314E+02	.287E+02	.404E+02	.569E+02	.508E+00	.531E+02	.237E+02	.210E+02	.108E+02	.128E+02
117.0	.134E+09	.246E+07	.243E+05	.254E+05	.152E+05	.164E+04	.547E+03	.822E+03	.260E+04	.459E+02
	.240E+02	.197E+02	.294E+02	.380E+02	.392E+00	.358E+02	.160E+02	.140E+02	.729E+01	.862E+01
119.0	.922E+08	.181E+07	.183E+05	.199E+05	.117E+05	.130E+04	.446E+03	.669E+03	.176E+04	.359E+02
	.198E+02	.151E+02	.216E+02	.262E+02	.303E+00	.248E+02	.111E+02	.962E+01	.506E+01	.596E+01
121.0	.651E+08	.134E+07	.139E+05	.154E+05	.900E+04	.102E+04	.357E+03	.536E+03	.123E+04	.291E+02
	.169E+02	.123E+02	.160E+02	.185E+02	.234E+00	.176E+02	.784E+01	.678E+01	.359E+01	.423E+01
123.0	.471E+08	.101E+07	.105E+05	.120E+05	.693E+04	.799E+03	.283E+03	.425E+03	.882E+03	.241E+02
	.145E+02	.104E+02	.120E+02	.134E+02	.180E+00	.128E+02	.569E+01	.489E+01	.261E+01	.307E+01
125.0	.348E+08	.757E+06	.801E+04	.919E+04	.531E+04	.620E+03	.220E+03	.332E+03	.647E+03	.198E+02
	.124E+02	.875E+01	.906E+01	.989E+01	.138E+00	.946E+01	.421E+01	.360E+01	.193E+01	.227E+01
127.0	.262E+08	.576E+06	.613E+04	.707E+04	.409E+04	.482E+03	.171E+03	.258E+03	.484E+03	.163E+02
	.105E+02	.740E+01	.689E+01	.744E+01	.106E+00	.713E+01	.317E+01	.270E+01	.146E+01	.171E+01
129.0	.200E+08	.441E+06	.471E+04	.543E+04	.315E+04	.374E+03	.132E+03	.200E+03	.368E+03	.133E+02
	.874E+01	.620E+01	.527E+01	.568E+01	.813E-01	.545E+01	.243E+01	.205E+01	.111E+01	.131E+01
131.0	.155E+08	.340E+06	.364E+04	.418E+04	.243E+04	.291E+03	.101E+03	.155E+03	.284E+03	.108E+02
	.723E+01	.517E+01	.407E+01	.440E+01	.626E-01	.422E+01	.188E+01	.158E+01	.863E+00	.101E+01
133.0	.121E+08	.265E+06	.284E+04	.325E+04	.190E+04	.228E+03	.785E+02	.120E+03	.222E+03	.880E+01
	.601E+01	.432E+01	.318E+01	.344E+01	.486E-01	.331E+01	.147E+01	.124E+01	.676E+00	.795E+00
135.0	.961E+07	.208E+06	.222E+04	.252E+04	.148E+04	.179E+03	.606E+02	.934E+02	.175E+03	.712E+01
	.493E+01	.358E+01	.249E+01	.272E+01	.377E-01	.262E+01	.117E+01	.976E+00	.535E+00	.630E+00
137.0	.769E+07	.164E+06	.175E+04	.197E+04	.116E+04	.141E+03	.472E+02	.728E+02	.140E+03	.578E+01
	.406E+01	.297E+01	.197E+01	.218E+01	.294E-01	.210E+01	.933E+00	.778E+00	.428E+00	.504E+00
139.0	.620E+07	.130E+06	.139E+04	.154E+04	.919E+03	.112E+03	.366E+02	.569E+02	.113E+03	.467E+01
	.332E+01	.244E+01	.156E+01	.175E+01	.230E-01	.169E+01	.752E+00	.625E+00	.345E+00	.406E+00
141.0	.504E+07	.104E+06	.111E+04	.121E+04	.727E+03	.888E+02	.284E+02	.446E+02	.914E+02	.375E+01
	.269E+01	.200E+01	.125E+01	.142E+01	.181E-01	.137E+01	.611E+00	.507E+00	.280E+00	.330E+00
143.0	.413E+07	.836E+05	.885E+03	.955E+03	.577E+03	.707E+02	.223E+02	.350E+02	.748E+02	.305E+01
	.221E+01	.165E+01	.100E+01	.116E+01	.143E-01	.112E+01	.500E+00	.414E+00	.229E+00	.270E+00
145.0	.340E+07	.674E+05	.713E+03	.755E+03	.463E+03	.568E+02	.174E+02	.277E+02	.615E+02	.245E+01
	.180E+01	.135E+01	.808E+00	.958E+00	.113E-01	.926E+00	.411E+00	.340E+00	.188E+00	.222E+00
147.0	.282E+07	.547E+05	.578E+03	.601E+03	.372E+03	.456E+02	.137E+02	.220E+02	.510E+02	.200E+01
	.147E+01	.111E+01	.656E+00	.793E+00	.898E-02	.767E+00	.341E+00	.281E+00	.156E+00	.184E+00
149.0	.235E+07	.446E+05	.469E+03	.482E+03	.300E+03	.369E+02	.109E+02	.175E+02	.424E+02	.162E+01
	.121E+01	.917E+00	.535E+00	.660E+00	.721E-02	.639E+00	.284E+00	.233E+00	.130E+00	.153E+00
155.0	.153E+07	.275E+05	.287E+03	.282E+03	.182E+03	.222E+02	.618E+01	.102E+02	.277E+02	.986E+00
	.744E+00	.574E+00	.330E+00	.430E+00	.421E-02	.417E+00	.185E+00	.151E+00	.844E-01	.100E+00
165.0	.683E+06	.109E+05	.112E+03	.995E+02	.694E+02	.834E+01	.208E+01	.362E+01	.123E+02	.363E+00
	.280E+00	.220E+00	.130E+00	.190E+00	.148E-02	.185E+00	.821E-01	.667E-01	.374E-01	.445E-01
175.0	.328E+06	.465E+04	.478E+02	.385E+02	.291E+02	.343E+01	.755E+00	.143E+01	.589E+01	.141E+00
	.110E+00	.878E-01	.556E-01	.911E-01	.580E-03	.888E-01	.393E-01	.318E-01	.179E-01	.213E-01
185.0	.167E+06	.211E+04	.214E+02	.161E+02	.132E+02	.150E+01	.290E+00	.604E+00	.299E+01	.566E-01
	.448E-01	.362E-01	.253E-01	.461E-01	.232E-03	.450E-01	.199E-01	.161E-01	.904E-02	.108E-01
195.0	.882E+05	.101E+04	.104E+02	.673E+01	.621E+01	.685E+00	.112E+00	.272E+00	.158E+01	.228E-01
	.182E-01	.148E-01	.121E-01	.243E-01	.989E-04	.238E-01	.105E-01	.846E-02	.477E-02	.571E-02

205.0	.482E+05	.506E+03	.497E+01	.291E+01	291E+01	.312E+00	.438E-01	.122E+00	.861E+00	.920E-02
	.737E-02	.604E-02	.605E-02	132E-01	381E-04	.130E-01	.573E-02	460E-02	.259E-02	.312E-02
215 0	.269E+05	261E+03	249E+01	.118E+01	.143E+01	148E+00	170E-01	.579E-01	.482E+00	.368E-02
	.296E-02	.244E-02	.310E-02	.737E-02	146E-04	724E-02	.320E-02	.256E-02	.145E-02	.174E-02
225 0	.154E+05	.139E+03	.128E+01	541E+00	.749E+00	747E-01	.748E-02	.291E-01	.275E+00	165E-02
	.133E-02	.110E-02	.166E-02	.420E-02	.580E-05	.413E-02	.182E-02	.146E-02	.824E-03	.993E-03
235 0	.895E+04	.749E+02	.700E+00	.241E+00	.399E+00	.391E-01	.328E-02	.152E-01	.160E+00	.733E-03
	.589E-03	.490E-03	874E-03	.244E-02	.203E-05	.240E-02	.106E-02	.848E-03	.478E-03	.577E-03
245 0	.523E+04	.408E+02	387E+00	.111E+00	.223E+00	.213E-01	.150E-02	.825E-02	.933E-01	.340E-03
	.273E-03	.228E-03	.468E-03	.143E-02	.888E-06	140E-02	.618E-03	.494E-03	.279E-03	.337E-03
255 0	.306E+04	.233E+02	221E+00	541E-01	.126E+00	.119E-01	.715E-03	.462E-02	.548E-01	.165E-03
	.133E-03	.112E-03	262E-03	837E-03	.433E-06	.820E-03	.362E-03	.289E-03	.163E-03	.197E-03
265 0	.182E+04	.126E+02	127E+00	.254E-01	.718E-01	.667E-02	.336E-03	259E-02	.326E-01	.790E-04
	.637E-04	.536E-04	130E-03	.494E-03	.200E-06	488E-03	.216E-03	.172E-03	.972E-04	.117E-03
275 0	.110E+04	.716E+01	.745E 01	.123E-01	.423E 01	387E-02	.162E-03	150E-02	.196E-01	.384E-04
	.309E-04	.261E-04	.658E-04	296E-03	.985E-07	.293E-03	.130E-03	104E-03	.586E-04	.709E-04
285 0	667E+03	.421E+01	445E-01	.672E-02	252E 01	229E-02	856E-04	.890E-03	.118E-01	.204E-04
	.165E-04	139E-04	365E-04	.179E-03	.531E-07	.178E-03	.788E-04	628E-04	.355E-04	.430E-04
295 0	406E+03	233E+01	.265E-01	.326E-02	150E-01	135E-02	.417E-04	.525E-03	.719E-02	.101E-04
	.810E-05	685E-05	205E-04	109E-03	257E-07	.108E-03	.480E-04	.383E-04	.216E-04	.262E-04

VIBRATIONAL TEMPERATURES(K)

ALT(KM)	KINETIC	CO2(01101)	CO2(10002)	CO2(02201)	CO2(10001)	CO2(11102)	CO2(03301)	CO2(11101)	CO2(00011)	CO2(20003)
	CO2(20002)	CO2(20001)	CO2(01111)	CO2(10012)	CO2(02211)	CO2(10011)	CO2(20013)	CO2(04411)	CO2(20012)	CO2(20011)
61.0	244.3	244.0	244.7	244.7	244.7	245.0	244.9	244.9	239.4	255.3
	262.1	269.6	216.9	267.2	257.3	266.6	330.4	330.5	339.5	346.6
63.0	238.8	238.6	238.4	238.4	238.4	239.4	239.3	239.3	235.7	255.8
	264.7	273.9	216.4	272.3	260.3	271.4	334.1	334.2	343.1	350.5
65.0	233.3	233.4	232.5	232.6	232.6	234.3	234.2	234.2	233.8	258.6
	269.0	279.5	220.6	278.0	263.4	276.7	337.9	338.0	346.9	354.6
67.0	227.8	228.2	226.5	226.5	226.6	229.5	229.4	229.4	237.4	263.0
	274.5	286.1	226.2	284.2	266.5	282.5	341.8	341.9	350.8	358.8
69.0	222.3	222.1	219.7	219.8	219.9	224.6	224.5	224.5	241.6	268.8
	281.0	293.4	231.9	291.0	269.7	288.7	345.9	346.0	354.9	363.1
71.0	216.9	217.4	213.4	213.5	213.7	220.6	220.4	220.4	245.5	275.6
	288.3	301.4	239.3	298.3	273.3	295.5	350.2	350.2	359.1	367.6
73.0	212.3	210.4	207.2	207.3	207.6	218.0	217.7	217.6	264.4	282.8
	295.8	309.5	245.2	306.1	276.9	302.8	354.9	354.8	363.7	372.4
75.0	208.4	210.8	205.0	205.0	205.2	218.1	217.6	217.4	277.3	290.2
	303.4	317.5	252.4	314.1	280.6	310.2	359.8	359.6	368.6	377.5
77.0	204.5	203.0	199.2	199.3	199.6	213.7	213.1	213.0	265.4	297.3
	310.6	325.3	255.4	321.6	283.2	317.1	365.0	364.6	373.6	382.8
79.0	200.6	199.2	196.7	196.6	197.0	214.2	213.4	213.2	286.1	304.0
	317.1	332.4	259.5	328.4	285.0	323.3	370.3	369.7	378.7	388.2
81.0	196.7	193.5	194.1	193.8	194.2	215.0	213.9	213.6	305.2	309.7
	322.5	338.3	260.8	334.0	285.4	328.5	375.9	375.0	383.9	393.7
83.0	192.7	187.4	191.5	191.0	191.6	212.9	211.7	211.4	307.0	314.4
	326.6	342.8	260.4	338.5	284.7	332.6	381.6	380.3	389.2	399.3
85.0	188.8	187.6	191.6	190.6	191.4	212.3	210.8	210.5	310.1	317.1
	328.5	345.1	261.7	341.9	282.9	335.6	387.4	385.5	394.4	404.9
87.0	186.9	185.0	190.6	189.1	190.3	210.1	208.3	208.3	307.5	312.1
	322.2	338.8	261.3	344.3	280.3	338.1	393.6	391.0	399.6	410.6
89.0	186.9	182.5	189.8	187.7	189.5	208.0	206.0	206.4	308.7	301.1
	309.4	325.7	260.5	346.0	277.0	340.2	400.1	396.4	404.8	416.3
91.0	186.9	181.1	139.6	186.6	189.4	206.6	204.1	205.1	314.4	291.0
	297.7	313.7	260.1	347.1	273.5	341.8	406.4	401.3	409.5	421.4
93.0	187.4	179.9	139.5	185.6	189.3	205.3	202.1	203.9	314.5	283.2
	288.3	304.1	259.5	347.7	269.8	343.3	412.2	405.7	413.5	426.0
95.0	188.5	179.4	190.0	184.9	189.9	204.7	200.6	203.5	313.6	277.5
	281.1	296.8	259.3	347.9	266.1	344.6	417.6	409.5	416.9	429.9
97.0	190.5	179.6	191.1	184.6	191.1	205.1	199.9	204.0	315.9	273.0
	275.3	290.8	259.4	347.8	262.7	345.9	422.3	412.6	419.7	433.2
99.0	193.4	179.2	192.1	184.2	192.2	205.8	199.2	204.9	316.4	268.9
	270.0	285.5	259.2	347.6	259.4	347.1	426.3	415.2	421.8	435.8
101.0	197.3	179.7	133.5	184.3	193.8	207.0	198.9	206.3	315.8	264.9
	265.2	280.5	253.3	347.2	256.6	348.3	429.5	417.2	423.5	437.8
103.0	202.4	180.4	195.0	184.7	195.6	208.6	199.0	208.1	315.1	261.0
	260.7	275.8	259.6	346.7	254.2	349.3	431.9	418.6	424.7	439.3
105.0	209.1	181.5	196.7	185.5	197.6	210.5	199.5	210.3	315.1	257.2
	256.5	271.3	260.1	346.2	252.4	350.3	433.8	419.7	425.6	440.4
107.0	218.1	183.2	198.6	186.9	200.0	212.7	200.7	213.0	314.9	253.4
	252.5	267.1	260.9	345.7	251.3	351.0	435.1	420.4	426.3	441.2

109.0	231.6	186.2	201 1	189.6	203 1	215.7	203.1	216.6	314.5	249.8
	248.9	262.9	262 2	345.3	251 3	351.7	436.1	420.9	426.9	441.8
111.0	252 0	191.1	204 6	194 2	207 5	219.9	207.3	221.6	313.7	246.7
	245.9	259 1	264 3	345 0	252 7	352.2	436.9	421.1	427.3	442.3
113 0	276 0	196.5	208.6	199.3	212 3	224 4	212 2	226 9	312.8	245.1
	244 7	256.4	266.5	344.9	254.9	352.6	437.4	421.2	427.7	442.7
115 0	300.0	201.0	211 9	203.6	216.4	228.3	216 4	231.5	312.2	245.0
	245.3	255.4	268.3	344 8	257 0	352.9	437 8	421 2	428.0	442.9
117.0	324.0	204.7	214.7	207.3	219 8	231.7	220.0	235.4	311.5	246.3
	247.4	255.8	269.7	344 8	258.8	353.1	438.0	421 2	428.2	443.1
119.0	348.0	207.7	217 0	210.3	222.6	234.4	222.9	238 5	311.1	248.4
	250.3	257.6	270 9	344 8	260.3	353.3	438.2	421 2	428.4	443.3
121.0	371 8	209 9	218.7	212.5	224.7	236.5	225 1	241.0	310.8	250.8
	253.4	260.0	271.7	344.8	261 5	353 4	438.3	421.1	428.5	443.4
123.0	394 9	211.5	220.0	214.1	226.3	238.1	226.7	242.8	310.5	253.1
	256.4	262.5	272 3	344.8	262 3	353 5	438 4	421 0	428.6	443.4
125 0	417.1	212.4	220.8	215 1	227.3	239 1	227 6	243.9	310.3	255.0
	258 8	264.8	272.6	344 9	262 8	353 6	438.5	420.9	428.7	443 5
127 0	438 5	212.9	221.3	215 6	227.9	239 8	228.2	244.6	310 1	256.6
	260 9	266 9	272.8	344.9	263.0	353.6	438.5	420 8	428.8	443 5
129 0	459.2	213.0	221 4	215.7	228 1	240.1	228.3	244.8	310.0	257 8
	262.5	268.6	272.8	344 8	263.1	353.6	438 5	420.8	428 8	443.6
131 0	478.8	212.9	221.3	215.6	228.0	240.2	228 2	244.8	309.9	258 6
	263 7	269.9	272 8	344.8	263.0	353 6	438.5	420.7	428.8	443 6
133.0	497 9	212 6	221 3	215.4	227.9	240.3	228.0	244 7	309.8	259.4
	264.7	271.1	272.7	344.8	262.9	353.6	438.5	420.6	428.8	443 6
135 0	516 3	212 1	220.9	214 9	227.5	240.0	227.6	244.2	309.7	259 8
	265 4	271.9	272.5	344.8	262.6	353.6	438.5	420.5	428.8	443 6
137 0	534 0	211.5	220.6	214.3	227.0	239.8	227.0	243.7	309.7	260.0
	265 9	272 5	272.3	344.8	262.3	353.6	438.5	420.4	428.8	443.6
139 0	551 1	210.8	220 1	213 6	226.5	239.4	226.4	243.1	309.6	260 0
	266.1	272.9	272 1	344 7	261.9	353 6	438.5	420.3	428.7	443.6
141 0	567.5	209 9	219.6	212 8	225 8	238.9	225.5	242.4	309 6	259 8
	266.1	273.0	271.7	344 7	261 4	353.6	438 5	420.2	428.7	443.6
143 0	583.3	209.1	218.9	211 9	225 0	238 3	224 8	241 5	309.6	259.7
	266.2	273.2	271.4	344.7	261.0	353.6	438 5	420.1	428.7	443 6
145 0	598.6	208.1	218.4	211 0	224 4	237 8	223 8	240 7	309.5	259.3
	265 9	273.0	271 1	344 7	260 4	353.6	438 5	420.1	428 6	443 5
147.0	613.2	207.2	217 8	210 0	223.6	237 2	223.0	239 9	309 5	259.0
	265 7	273.0	270.7	344 6	259.9	353.6	438.4	420.0	428 6	443.5
149 0	627.3	206.2	217 1	209 2	222 8	236.6	222.1	239.0	309.5	258.5
	265.4	272 7	270 3	344 6	259 4	353.6	438.4	419.9	428 6	443.5
155 0	665 3	203.7	215 5	206.7	221 0	235.0	219.8	236 9	309 4	257 2
	264.4	272.0	269.4	344.5	258 0	353 5	438 4	419.8	428 5	443.5
165 0	721 9	198.7	212.2	201.6	217.2	231.6	215.2	232.7	309 4	253.8
	261 3	269.3	267.4	344 4	255 1	353 5	438.3	419 5	428 3	443 4
175 0	768.8	194 0	209 3	197 1	214 1	228.6	210 8	229 2	309 3	250 0
	257 8	265.9	265 4	344 3	252 6	353 4	438 2	419 3	428.2	443 4
185 0	807 7	189.7	206.4	193 3	211 4	225.9	206 5	226 0	309.2	246 1
	254 0	262.3	263 6	344 2	249 7	353.4	438.1	419 2	428 1	443.3
195 0	839 9	186.0	204 4	188.8	208 9	223.2	202 0	223.3	309 2	241.8
	249 7	258.0	262 0	344 2	247.2	353.4	438.0	419.0	428 0	443 3

205.0	865.7	182.9	201.5	184.6	205.6	220.0	197.4	220.1	309.2	237.0
	244.9	253.2	260.6	344.1	243.2	353.3	438.0	418.9	427.9	443.2
215.0	887.9	180.2	199.1	179.0	202.9	217.1	192.6	217.4	309.2	232.0
	239.8	248.2	259.3	344.0	239.0	353.3	437.9	418.8	427.8	443.2
225.0	903.2	177.8	197.0	175.5	201.1	215.1	189.3	215.4	309.2	228.5
	236.3	244.6	258.3	343.9	235.1	353.2	437.9	418.8	427.8	443.2
235.0	911.6	175.4	195.6	171.3	199.4	213.3	185.8	213.7	309.1	224.7
	232.4	240.7	256.7	344.0	229.9	353.2	437.9	418.7	427.7	443.2
245.0	924.6	173.1	194.5	167.8	198.5	212.2	182.9	212.7	309.1	221.6
	229.2	237.5	255.4	343.9	227.1	353.2	437.8	418.7	427.7	443.2
255.0	942.2	172.3	194.0	165.1	197.8	211.4	180.6	212.0	309.2	219.1
	226.7	235.0	254.7	344.0	225.3	353.2	437.8	418.7	427.7	443.2
265.0	954.1	169.5	193.2	161.8	196.9	210.5	177.9	211.1	309.2	216.3
	223.8	232.1	252.0	343.8	222.9	353.2	437.8	418.6	427.7	443.2
275.0	960.4	167.7	192.7	158.8	196.5	209.8	175.5	210.5	309.0	213.6
	221.1	229.2	249.5	343.7	220.9	353.1	437.8	418.6	427.7	443.1
285.0	966.6	166.8	192.4	157.5	196.1	209.5	174.0	210.1	308.9	211.9
	219.4	227.6	248.2	343.6	219.9	353.1	437.8	418.6	427.7	443.1
295.0	972.9	164.1	191.9	154.6	195.7	208.9	171.7	209.7	308.9	209.3
	216.8	224.9	247.1	343.6	217.8	353.0	437.8	418.6	427.6	443.1

O3 RADIATIVE PROPERTIES

STATE	ENERGY(CM-1)	DEGENERACY
O3(000)	.000	1.
O3(010)	700.931	1.
O3(001)	1042.084	1.
O3(100)	1103.140	1.
O3(020)	1399.275	1.
O3(011)	1726.528	1.
O3(110)	1796.261	1.
O3(002)	2057.892	1.
O3(101)	2110.785	1.
O3(200)	2201.157	1.
O3(111)	2785.245	1.
O3(003)	3041.200	1.
O3(004)	3988.000	1.
O3(005)	4910.000	1.
O3(006)	5803.000	1.
O3(007)	6665.000	1.
O3(008)	7497.000	1.
O3(009)	8299.000	1.

TRANSITION		FREQUENCY(CM-1)	ESHINE T(K)	RADIANCE
O3(010)	-O3(000)	700.931	230.0	Y
O3(001)	-O3(000)	1042.084	260.0	Y
O3(100)	-O3(000)	1103.140	285.0	Y
O3(011)	-O3(000)	1726.528	240.0	Y
O3(110)	-O3(000)	1796.261	250.0	Y
O3(002)	-O3(000)	2057.892	280.0	Y
O3(101)	-O3(000)	2110.785	230.0	Y
O3(200)	-O3(000)	2201.157	270.0	Y
O3(111)	-O3(000)	2785.245	285.0	Y
O3(003)	-O3(000)	3041.200	280.0	Y
O3(020)	-O3(010)	698.344	230.0	Y
O3(011)	-O3(010)	1025.597	260.0	Y
O3(110)	-O3(010)	1095.330	285.0	Y
O3(111)	-O3(010)	2084.314	280.0	Y
O3(002)	-O3(001)	1015.808	250.0	Y
O3(101)	-O3(100)	1007.645	250.0	Y
O3(003)	-O3(002)	983.308	285.0	Y
O3(004)	-O3(003)	946.800	285.0	Y
O3(005)	-O3(004)	922.000	285.0	Y
O3(006)	-O3(005)	893.000	285.0	Y
O3(007)	-O3(006)	862.000	285.0	Y
O3(008)	-O3(007)	832.000	285.0	Y
O3(009)	-O3(008)	802.000	285.0	Y

EXCITED STATE NUMBER DENSITIES(MOLEC/CM3)

ALT(KM)	03(000)	03(010)	03(001)	03(100)	03(020)	03(011)	03(110)	03(002)	03(101)	03(200)
	03(111)	03(003)	03(004)	03(005)	03(006)	03(007)	03(008)	03(009)		
61 0	.575E+10	.927E+08	.125E+08	.870E+07	.152E+07	.220E+06	.147E+06	.648E+05	.471E+05	.275E+05
	.549E+03	.355E+05	.175E+05	.842E+04	.370E+04	.139E+04	.372E+03	.678E+02		
63 0	.334E+10	.490E+08	.632E+07	.438E+07	.729E+06	.102E+06	.670E+05	.449E+05	.323E+05	.186E+05
	.272E+03	.319E+05	157E+05	.759E+04	.333E+04	.125E+04	.335E+03	.610E+02		
65 0	.172E+10	.230E+08	.285E+07	.196E+07	.309E+06	.416E+05	.270E+05	.337E+05	.240E+05	.137E+05
	.141E+03	.285E+05	.141E+05	.680E+04	.299E+04	.112E+04	.301E+03	.546E+02		
67 0	.798E+09	.966E+07	117E+07	.792E+06	.117E+06	.153E+05	.977E+04	.274E+05	.193E+05	.108E+05
	.821E+02	252E+05	.125E+05	.605E+04	.266E+04	.998E+03	.268E+03	.486E+02		
69 0	355E+09	.391E+07	.470E+06	.317E+06	.426E+05	.551E+04	.342E+04	.233E+05	.163E+05	.898E+04
	.544E+02	.221E+05	.110E+05	.533E+04	.235E+04	.881E+03	.237E+03	.429E+02		
71 0	.143E+09	.147E+07	.189E+06	.126E+06	.143E+05	.191E+04	.115E+04	.213E+05	.148E+05	.805E+04
	.407E+02	.204E+05	.102E+05	.494E+04	.218E+04	.820E+03	.220E+03	.400E+02		
73.0	.671E+08	.674E+06	101E+06	.667E+05	.592E+04	.864E+03	.505E+03	.204E+05	.140E+05	.752E+04
	.333E+02	.192E+05	.970E+04	.471E+04	.208E+04	.784E+03	.211E+03	.384E+02		
75 0	359E+08	.372E+06	.674E+05	.441E+05	.299E+04	.491E+03	.280E+03	.189E+05	.129E+05	.686E+04
	.270E+02	.176E+05	.894E+04	.435E+04	.193E+04	.729E+03	.197E+03	.359E+02		
77.0	.226E+08	.245E+06	.522E+05	.339E+05	.180E+04	.331E+03	.184E+03	.173E+05	.117E+05	.614E+04
	.214E+02	.157E+05	.806E+04	.394E+04	.175E+04	.665E+03	.180E+03	.329E+02		
79 0	.182E+08	.195E+06	.451E+05	.290E+05	.130E+04	.262E+03	.138E+03	.154E+05	.104E+05	.536E+04
	.164E+02	.136E+05	709E+04	.348E+04	.155E+04	593E+03	.161E+03	.296E+02		
81 0	.197E+08	.186E+06	.412E+05	.263E+05	.113E+04	.240E+03	.115E+03	.127E+05	.845E+04	.432E+04
	.116E+02	.109E+05	.573E+04	.283E+04	.127E+04	.487E+03	.133E+03	.246E+02		
83 0	.297E+08	.227E+06	.435E+05	.275E+05	.125E+04	.281E+03	.114E+03	.967E+04	.639E+04	.322E+04
	.800E+01	.800E+04	.429E+04	.213E+04	.961E+03	.371E+03	.102E+03	.190E+02		
85 0	.411E+08	.275E+06	.490E+05	.307E+05	.137E+04	.348E+03	.120E+03	.714E+04	.467E+04	.232E+04
	.594E+01	.568E+04	.309E+04	.154E+04	.702E+03	.273E+03	.757E+02	.142E+02		
87 0	.446E+08	.292E+06	.539E+05	.335E+05	.139E+04	.398E+03	.128E+03	.621E+04	.403E+04	.199E+04
	.534E+01	478E+04	.265E+04	.133E+04	.610E+03	.239E+03	.669E+02	.126E+02		
89 0	.411E+08	.277E+06	.534E+05	.333E+05	.133E+04	.411E+03	.133E+03	.552E+04	.357E+04	.176E+04
	.482E+01	.414E+04	234E+04	119E+04	.551E+03	.218E+03	.616E+02	.118E+02		
91 0	.327E+08	.225E+06	.446E+05	.278E+05	.110E+04	.357E+03	.119E+03	.420E+04	.270E+04	.133E+04
	376E+01	.308E+04	.178E+04	917E+03	.430E+03	.172E+03	.490E+02	.943E+01		
93 0	238E+08	.166E+06	330E+05	.206E+05	.833E+03	.278E+03	.989E+02	.271E+04	.172E+04	.851E+03
	.267E+01	.195E+04	115E+04	.597E+03	.283E+03	.114E+03	.328E+02	.637E+01		
95.0	.168E+08	.119E+06	.233E+05	.146E+05	.626E+03	.207E+03	.816E+02	.152E+04	.957E+03	.474E+03
	184E+01	.107E+04	637E+03	.335E+03	.160E+03	.649E+02	.187E+02	.367E+01		
97 0	.114E+08	.819E+05	.158E+05	.992E+04	460E+03	.148E+03	.664E+02	.774E+03	.482E+03	.240E+03
	124E+01	.533E+03	.319E+03	.169E+03	.807E+02	.329E+02	.955E+01	.188E+01		
99.0	.693E+07	.514E+05	976E+04	.619E+04	.310E+03	.951E+02	.497E+02	.372E+03	.228E+03	.114E+03
	.769E+00	250E+03	.150E+03	.792E+02	.380E+02	155E+02	.452E+01	.891E+00		
101 0	420E+07	.322E+05	.605E+04	387E+04	.210E+03	.607E+02	.373E+02	.173E+03	.104E+03	.527E+02
	.476E+00	.112E+03	.673E+02	356E+02	.170E+02	.698E+01	.203E+01	.401E+00		
103 0	.294E+07	233E+05	.433E+04	.280E+04	.163E+03	.445E+02	.320E+02	.795E+02	.470E+02	.241E+02
	.339E+00	.487E+02	.291E+02	.153E+02	.734E+01	.300E+01	.874E+00	.173E+00		
105 0	.206E+07	169E+05	.314E+04	.207E+04	.127E+03	.326E+02	.272E+02	.366E+02	.214E+02	.112E+02
	243E+00	.204E+02	.121E+02	.636E+01	.304E+01	.124E+01	.361E+00	.713E-01		
107 0	.145E+07	.124E+05	.232E+04	155E+04	989E+02	240E+02	.229E+02	.171E+02	.102E+02	546E+01
	.174E+00	.828E+01	.484E+01	254E+01	121E+01	493E+00	.143E+00	.283E-01		

109.0	.102E+07	.911E+04	.174E+04	.119E+04	.783E+02	.178E+02	.194E+02	.831E+01	.531E+01	.292E+01
	.125E+00	318E+01	.181E+01	.946E+00	.450E+00	.183E+00	.532E-01	.105E-01		
111.0	.665E+06	.633E+04	.125E+04	.885E+03	.592E+02	.124E+02	.154E+02	.418E+01	.298E+01	.170E+01
	.842E-01	.114E+01	.625E+00	.324E+00	.154E+00	.625E-01	.181E-01	.357E-02		
113.0	.398E+06	400E-04	838E+03	608E+03	400E+02	789E+01	110E+02	.222E+01	.174E+01	.104E+01
	.518E-01	.419E+00	.215E+00	.111E+00	.527E-01	.214E-01	.619E-02	.122E-02		
115.0	.249E+06	.258E+04	.579E+03	.430E+03	.268E+02	.512E+01	.777E+01	.133E+01	.112E+01	.685E+00
	.329E-01	.173E+00	.815E-01	.420E-01	.198E-01	.802E-02	.232E-02	.456E-03		
117.0	.162E+06	.170E+04	.411E+03	.310E+03	.180E+02	.339E+01	.550E+01	.860E+00	.767E+00	.476E+00
	.216E-01	.800E-01	.335E-01	.172E-01	.810E-02	.327E-02	.947E-03	.186E-03		
119.0	.108E+06	.114E+04	.296E+03	.226E+03	.122E+02	.228E+01	.390E+01	.587E+00	.541E+00	.339E+00
	.145E-01	.407E-01	.147E-01	.752E-02	.354E-02	.143E-02	.413E-03	.810E-04		
121.0	.747E+05	.785E+03	.217E+03	.167E+03	.834E+01	.157E+01	.277E+01	.414E+00	.390E+00	.245E+00
	.100E-01	.226E-01	.686E-02	.349E-02	.164E-02	.662E-03	.191E-03	.375E-04		
123.0	.528E+05	.549E+03	.161E+03	.124E+03	.577E+01	.110E+01	.199E+01	.300E+00	.286E+00	.179E+00
	.705E-02	.136E-01	.339E-02	.172E-02	.808E-03	.326E-03	.941E-04	.184E-04		
125.0	.382E+05	.391E+03	.121E+03	.931E+02	.405E+01	.783E+00	.143E+01	221E+00	.212E+00	.132E+00
	.506E-02	.865E-02	.176E-02	.889E-03	.417E-03	.168E-03	.485E-04	951E-05		
127.0	.281E+05	.283E+03	.912E+02	.702E+02	.288E+01	.566E+00	.104E+01	.166E+00	.159E+00	.975E-01
	.370E-02	.582E-02	.960E-03	.481E-03	.225E-03	.908E-04	.262E-04	.513E-05		
129.0	.210E+05	.207E+03	.694E+02	.532E+02	.207E+01	.416E+00	.764E+00	.125E+00	.121E+00	.724E-01
	275E-02	.407E-02	.542E-03	.270E-03	.126E-03	.509E-04	.147E-04	287E-05		
131.0	.160E+05	.154E+03	.533E+02	.406E+02	.151E+01	.309E+00	.566E+00	.958E-01	.922E-01	.540E-01
	.207E-02	.294E-02	.318E-03	.157E-03	.735E-04	.296E-04	.853E-05	.167E-05		
133.0	.123E+05	117E+03	.414E+02	.312E+02	.112E+01	.233E+00	.424E+00	.740E-01	.711E-01	.406E-01
	.158E-02	.217E-02	.193E-03	.942E-04	.441E-04	.177E-04	.511E-05	.100E-05		
135.0	956E+04	.890E+02	322E+02	.241E+02	.839E+00	.178E+00	.320E+00	.575E-01	.552E-01	.306E-01
	.122E-02	.164E-02	.120E-03	.578E-04	.271E-04	.109E-04	.314E-05	.615E-06		
137.0	.752E+04	.687E+02	.254E+02	.188E+02	.636E+00	.137E+00	.244E+00	.452E-01	.433E-01	.232E-01
	.952E-03	.126E-02	.767E-04	.364E-04	.170E-04	.685E-05	.197E-05	.387E-06		
139.0	.596E+04	.535E+02	.200E+02	.146E+02	.487E+00	.107E+00	.188E+00	.357E-01	.341E-01	.176E-01
	.750E-03	.982E-03	500E-04	.234E-04	.109E-04	.439E-05	.127E-05	.248E-06		
141.0	.477E+04	.421E+02	.159E+02	.115E+02	.377E+00	839E-01	.146E+00	.283E-01	.270E-01	.135E-01
	.596E-03	.774E-03	.333E-04	.153E-04	.714E-05	.287E 05	828E-06	.162E-06		
143.0	.384E+04	.334E+02	.128E+02	.909E+01	.294E+00	665E-01	.114E+00	.227E-01	.216E-01	.104E-01
	.477E-03	.616E-03	.227E-04	.102E-04	.476E-05	191E-05	.551E-06	.108E-06		
145.0	.312E+04	.267E+02	.102E+02	.721E+01	.232E+00	.531E-01	901E-01	.182E-01	.173E-01	.805E-02
	.385E-03	.495E-03	.157E-04	.688E-05	.321E-05	129E-05	.372E-06	.728E-07		
147.0	.255E+04	.215E+02	.829E+01	.576E+01	.184E+00	.427E-01	.717E-01	.147E-01	.140E-01	.627E-02
	.312E-03	.401E-03	.110E-04	.472E-05	.220E-05	.885E-06	.255E-06	.499E-07		
149.0	.209E+04	.174E+02	.674E+01	.462E+01	.147E+00	.346E-01	574E-01	.120E-01	.114E-01	.491E-02
	.255E-03	.327E-03	.789E-05	.328E-05	.153E-05	.614E-06	.177E-06	.346E-07		
155.0	.133E+04	.107E+02	.415E+01	.276E+01	.882E-01	.213E-01	.345E-01	.739E-02	701E-02	.277E-02
	.160E-03	.204E-03	.354E-05	.133E-05	.621E-06	.249E-06	.718E-07	.141E-07		
165.0	.552E+03	.428E+01	.162E+01	.103E+01	.336E-01	.844E-02	.131E-01	.289E-02	.277E-02	.939E-03
	.656E-04	.836E-04	.931E-06	.279E-06	.130E-06	.521E-07	.150E-07	.293E-08		
175.0	249E+03	.187E+01	.680E+00	.422E+00	.143E-01	.369E-02	558E-02	.122E-02	.120E-02	.361E-03
	.293E-04	.373E-04	.308E-06	696E-07	.321E-07	.129E-07	.371E-08	.726E-09		
185.0	.119E+03	.878E+00	.306E+00	.188E+00	654E-02	.173E-02	.256E-02	.554E-03	.560E-03	154E-03
	.139E-04	.177E-04	120E-06	.197E-07	900E-08	.361E-08	.104E-08	.203E-09		
195.0	.598E+02	.433E+00	144E+00	.894E-01	.317E-02	.849E-03	.125E-02	.262E-03	274E 03	708E-04
	.693E-05	.882E-05	.526E-07	.613E-08	.276E-08	.111E-08	.319E 09	.625E-10		

205.0	.309E+02	.222E+00	700E-01	.445E-01	.161E-02	.435E-03	.633E-03	.128E-03	.140E-03	.345E-04
	.358E-05	.454E-05	250E-07	.207E-08	.916E-09	.368E-09	.106E-09	.207E-10		
215.0	.164E+02	.117E+00	.354E-01	.230E-01	.841E-03	.229E-03	.331E-03	.653E-04	.736E-04	.175E-04
	.189E-05	.240E-05	.125E-07	.743E-09	320E-09	.128E-09	.369E-10	.722E-11		
225.0	.893E+01	630E-01	.183E-01	.122E-01	.451E-03	.123E-03	.178E-03	.340E-04	.397E-04	.922E-05
	.103E-05	130E-05	.653E-08	.281E-09	.116E-09	.466E-10	.134E-10	.263E-11		
235.0	.495E+01	348E-01	.980E-02	.669E-02	.247E-03	.681E-04	.978E-04	.183E-04	.219E-04	.498E-05
	.568E-06	717E-06	.353E-08	.113E-09	.444E-10	.178E-10	.512E-11	.100E-11		
245.0	.275E+01	.193E-01	.530E-02	.368E-02	.137E-03	.377E-04	.542E-04	.992E-05	.121E-04	.273E-05
	.316E-06	.398E-06	.193E-08	.462E-10	.171E-10	.683E-11	.196E-11	.384E-12		
255.0	.154E+01	.108E-01	.290E-02	.204E-02	.760E-04	.210E-04	.302E-04	.544E-05	.676E-05	.150E-05
	.176E-06	.222E-06	.106E-08	.195E-10	.659E-11	.263E-11	.759E-12	.148E-12		
265.0	.874E+00	.609E-02	.161E-02	.115E-02	.430E-04	.119E-04	.171E-04	.304E-05	.383E-05	.845E-06
	.100E-06	.126E-06	.599E-09	.869E-11	.264E-11	.105E-11	.301E-12	.592E-13		
275.0	.504E+00	.351E-02	912E-03	.663E-03	.247E-04	.686E-05	.982E-05	.172E-05	.221E-05	.483E-06
	.577E-07	.726E-07	.343E-09	.409E-11	.108E-11	.427E-12	.125E-12	.243E-13		
285.0	292E+00	.203E-02	.521E-03	.383E-03	.143E-04	.397E-05	.568E-05	.987E-06	.128E-05	.278E-06
	.334E-07	420E-07	198E-09	.199E-11	.452E-12	.175E-12	.499E-13	.955E-14		
295.0	.170E+00	.118E-02	300E-03	.222E-03	830E-05	.231E-05	.330E-05	.569E-06	.743E-06	.161E-06
	195E-07	.245E-07	115E-09	994E-12	.196E-12	.734E-13	.209E-13	.400E-14		

VIBRATIONAL TEMPERATURES(K)

ALT(KM)	KINETIC	O3(010)	O3(001)	O3(100)	O3(020)	O3(011)	O3(110)	O3(002)	O3(101)	O3(200)
	O3(111)	O3(003)	O3(004)	O3(005)	O3(006)	O3(007)	O3(008)	O3(009)		
61.0	244.3	244.3	244.4	244.4	244.3	244.2	244.4	259.9	259.3	258.5
	247.9	364.8	451.6	525.9	585.6	629.3	651.6	654.0		
63.0	238.8	238.9	239.2	239.1	238.8	238.9	238.9	264.0	263.0	261.8
	245.5	378.5	467.8	543.7	604.3	648.0	669.4	670.1		
65.0	233.3	233.6	234.1	234.1	233.4	233.7	233.6	273.1	271.7	269.6
	245.6	397.4	489.9	567.8	629.4	673.2	693.2	691.5		
67.0	227.8	228.4	229.6	229.5	228.1	228.7	228.5	288.0	285.7	282.5
	249.1	422.2	518.7	599.2	662.0	705.5	723.6	718.7		
69.0	222.3	223.7	226.3	226.0	223.0	224.3	223.8	307.4	304.0	299.2
	255.4	451.8	552.8	636.0	700.0	743.0	758.5	749.6		
71.0	216.9	220.2	226.2	225.6	218.5	221.3	220.3	336.1	330.9	323.6
	265.9	494.0	600.9	687.6	752.7	794.5	806.0	791.3		
73.0	212.3	219.2	230.7	229.6	215.7	220.6	219.1	365.6	358.4	348.2
	276.1	536.4	649.0	738.6	804.3	844.4	851.5	830.7		
75.0	208.4	220.6	238.8	236.8	214.3	221.8	219.7	392.2	383.0	369.8
	284.2	574.0	691.4	783.2	849.1	887.4	890.4	864.1		
77.0	204.5	222.8	247.0	244.1	213.3	223.2	220.5	412.6	401.4	385.7
	289.0	601.6	722.8	816.2	882.1	919.1	918.9	888.5		
79.0	200.6	222.5	249.9	246.5	211.0	222.9	219.3	418.6	406.6	389.6
	288.0	608.0	731.0	825.1	891.4	928.3	927.4	896.0		
81.0	196.7	216.4	243.0	239.8	206.1	219.5	214.4	402.9	391.7	375.9
	279.4	583.2	704.7	798.3	865.3	904.1	906.3	878.5		
83.0	192.7	207.1	229.8	227.2	199.8	214.8	207.2	368.8	359.7	346.9
	264.9	532.4	649.0	740.2	807.7	849.4	857.6	837.3		
85.0	188.8	201.4	222.7	220.4	195.2	212.7	202.7	342.0	334.4	323.8
	254.4	492.4	604.3	693.2	760.5	804.3	816.9	802.4		
87.0	186.9	200.5	223.2	220.7	194.0	213.7	202.5	333.5	326.2	316.1
	251.4	478.6	589.6	677.9	745.5	790.1	804.3	792.0		
89.0	186.9	201.7	225.6	222.9	194.8	215.8	204.4	332.1	324.8	314.9
	251.1	475.4	587.0	676.0	744.2	789.5	804.3	792.5		
91.0	186.9	202.5	227.3	224.5	195.5	217.5	206.4	330.5	323.0	313.3
	250.8	472.0	584.4	674.0	742.8	788.9	804.3	793.0		
93.0	187.4	203.0	227.9	225.1	196.2	218.7	208.6	326.1	318.6	309.3
	250.4	465.1	577.2	667.0	736.3	783.1	799.4	789.1		
95.0	188.5	203.5	227.7	225.1	197.4	219.8	211.2	317.9	310.7	302.2
	250.0	452.8	563.5	652.6	721.9	769.2	786.9	778.4		
97.0	190.5	204.4	227.8	225.3	199.0	220.8	214.4	308.5	301.6	294.1
	250.0	438.9	547.4	635.2	704.1	751.9	770.9	764.5		
99.0	193.4	205.6	228.4	226.1	201.0	221.9	218.2	301.1	294.2	287.6
	250.2	427.7	534.2	620.8	689.2	737.2	757.3	752.5		
101.0	197.3	207.1	229.1	227.1	203.2	222.9	222.2	293.2	286.3	280.6
	250.5	415.5	519.6	604.8	672.5	720.5	741.7	738.6		
103.0	202.4	208.5	229.9	228.2	205.4	223.8	226.1	281.5	275.0	270.4
	250.8	397.4	497.9	580.7	647.2	695.1	717.7	717.1		
105.0	209.1	210.0	231.1	229.8	207.6	224.7	230.0	270.6	264.7	261.2
	251.1	379.7	476.3	556.7	621.8	669.5	693.3	695.0		
107.0	218.1	211.7	232.8	232.0	209.9	225.6	233.8	260.9	256.0	253.6
	251.5	362.4	455.0	532.9	595.5	643.8	668.7	672.6		

109.0	231.6	213.8	235.3	235.1	212.5	226.7	237.7	252.7	249.7	248.2
	251.9	345.2	433.5	508.6	570.6	617.4	643.3	649.2		
111.0	252.0	216.7	239.0	239.7	215.9	228.1	242.2	247.2	246.6	246.0
	252.3	329.6	413.4	486.1	546.4	592.6	619.2	627.0		
113.0	276.0	219.2	243.3	244.8	218.7	229.4	246.2	244.8	246.1	246.3
	252.7	317.9	397.6	468.2	527.2	572.8	599.9	609.0		
115.0	300.0	220.7	247.2	249.4	220.3	230.1	249.1	243.8	246.7	247.3
	253.0	308.6	384.2	453.0	510.8	555.9	583.3	593.5		
117.0	324.0	221.4	250.9	253.6	221.2	230.6	251.2	243.8	247.7	248.6
	253.1	301.4	372.8	439.9	496.7	541.3	569.0	580.1		
119.0	348.0	221.6	254.0	257.1	221.4	230.7	252.5	244.1	248.8	249.8
	253.2	295.7	362.9	428.6	484.4	528.5	556.4	568.2		
121.0	371.8	221.4	256.7	260.0	221.2	230.6	253.3	244.6	249.7	250.8
	253.2	291.5	354.1	418.5	473.5	517.2	545.2	557.7		
123.0	394.9	220.8	258.8	262.3	220.7	230.4	253.7	245.2	250.4	251.5
	253.2	288.3	346.5	409.8	464.0	507.3	535.4	548.4		
125.0	417.1	220.1	260.4	263.8	220.0	230.1	253.6	245.6	251.0	251.8
	253.1	286.0	339.7	402.0	455.5	498.4	526.6	540.0		
127.0	438.5	219.2	261.6	264.9	219.1	229.7	253.3	245.9	251.4	251.9
	252.9	284.3	333.7	395.0	447.9	490.5	518.8	532.5		
129.0	459.2	218.3	262.4	265.4	218.2	229.3	252.8	246.1	251.6	251.8
	252.8	283.0	328.4	388.7	441.1	483.3	511.6	525.7		
131.0	478.8	217.4	262.9	265.6	217.3	228.9	252.2	246.2	251.8	251.4
	252.7	282.1	323.6	383.1	434.9	476.9	505.2	519.6		
133.0	497.9	216.5	263.3	265.6	216.4	228.5	251.5	246.3	251.8	250.9
	252.6	281.4	319.3	378.0	429.3	471.1	499.4	514.0		
135.0	516.3	215.6	263.4	265.3	215.5	228.1	250.8	246.3	251.8	250.3
	252.4	280.9	315.4	373.3	424.2	465.7	494.0	508.8		
137.0	534.0	214.8	263.5	264.8	214.7	227.7	250.1	246.3	251.7	249.6
	252.3	280.5	311.8	369.0	419.4	460.7	489.0	504.0		
139.0	551.1	214.0	263.2	264.1	213.9	227.3	249.3	246.2	251.6	248.8
	252.2	280.1	308.5	364.9	415.0	456.0	484.3	499.5		
141.0	567.5	213.2	263.0	263.3	213.1	226.9	248.6	246.0	251.4	247.9
	252.1	279.9	305.6	361.2	410.9	451.7	479.9	495.3		
143.0	583.3	212.5	262.7	262.5	212.4	226.6	247.9	245.9	251.2	247.0
	252.0	279.7	302.8	357.7	407.1	447.7	475.9	491.4		
145.0	598.6	211.3	262.2	261.5	211.8	226.2	247.3	245.7	251.0	246.1
	251.9	279.5	300.3	354.4	403.5	443.9	472.1	487.8		
147.0	613.2	211.2	261.8	260.6	211.1	225.9	246.7	245.5	250.8	245.2
	251.8	279.3	298.0	351.4	400.1	440.3	468.5	484.3		
149.0	627.3	210.6	261.4	259.6	210.6	225.6	246.1	245.3	250.5	244.3
	251.7	279.2	295.9	348.5	396.9	436.9	465.1	481.0		
155.0	665.3	209.4	260.0	257.1	209.3	225.0	244.8	244.8	250.0	242.2
	251.6	279.0	290.7	341.0	388.7	428.2	456.3	472.5		
165.0	721.9	207.5	257.1	252.5	207.4	224.0	242.7	243.5	248.9	238.4
	251.3	278.7	284.0	330.0	376.6	415.4	443.4	459.9		
175.0	768.8	206.2	253.9	248.7	206.1	223.4	241.4	242.2	248.1	235.6
	251.1	278.4	279.7	321.1	366.6	404.9	432.7	449.5		
185.0	807.7	205.3	251.3	246.0	205.2	222.9	240.4	241.1	247.5	233.5
	251.0	278.3	277.0	313.6	358.2	395.9	423.6	440.6		
195.0	839.9	204.6	248.8	244.0	204.5	222.6	239.8	240.0	247.1	232.1
	250.9	278.2	275.2	307.2	350.9	388.1	415.6	432.8		

205.0	865.7	204.2	246.1	242.5	204.1	222.3	239.3	238.9	246.8	231.0
	250.9	278.1	274.0	301.5	344.4	381.2	408.6	425.9		
215.0	887.9	203.9	244.2	241.5	203.7	222.2	239.0	238.1	246.6	230.3
	250.8	278.0	273.3	296.6	338.5	374.9	402.1	419.6		
225.0	903.2	203.6	242.2	240.8	203.5	222.0	238.8	237.3	246.4	229.8
	250.8	277.9	272.8	292.1	333.1	369.1	396.2	413.8		
235.0	911.6	203.4	240.9	240.3	203.3	221.9	238.6	236.7	246.3	229.4
	250.8	277.9	272.4	288.3	328.2	363.9	390.9	408.5		
245.0	924.6	203.3	239.8	239.9	203.2	221.8	238.5	236.2	246.2	229.1
	250.8	277.8	272.2	284.7	323.5	358.9	385.7	403.4		
255.0	942.2	203.2	238.9	239.6	203.0	221.8	238.4	235.9	246.2	228.8
	250.7	277.8	272.0	281.5	319.0	353.9	380.6	398.4		
265.0	954.1	203.1	238.1	239.4	203.0	221.8	238.3	235.6	246.2	228.7
	250.7	277.8	271.9	278.8	314.7	349.4	375.9	393.8		
275.0	960.4	203.0	237.4	239.2	202.9	221.7	238.3	235.3	246.1	228.5
	250.7	277.8	271.8	276.6	310.8	345.0	371.6	389.4		
285.0	966.6	203.0	236.9	239.1	202.8	221.7	238.2	235.0	246.1	228.4
	250.7	277.8	271.8	274.8	307.0	340.8	366.9	384.5		
295.0	972.9	202.9	236.4	239.0	202.8	221.7	238.2	234.8	246.1	228.4
	250.7	277.7	271.7	273.1	303.7	336.8	362.8	380.5		

CO RADIATIVE PROPERTIES

STATE	ENERGY(CM-1)	DEGENERACY
CO(0)	.000	1.
CO(1)	2143.272	1.
CO(2)	4260.063	1.

TRANSITION		FREQUENCY(CM-1)	ESHINE T(K)	RADIANCE
CO(1)	-CO(0)	2143.272	230.0	Y
CO(2)	-CO(0)	4260.063	280.0	Y
CO(2)	-CO(1)	2115.791	280.0	Y

EXCITED STATE NUMBER DENSITIES(MOLEC/CM3)

ALT(KM)	CO(0)	CO(1)	CO(2)
61.0	.954E+09	.817E+04	.492E+02
63.0	.104E+10	.946E+04	.539E+02
65.0	.114E+10	.110E+05	.588E+02
67.0	.121E+10	.125E+05	.625E+02
69.0	.122E+10	.133E+05	.629E+02
71.0	.123E+10	.141E+05	.635E+02
73.0	.125E+10	.149E+05	.647E+02
75.0	.124E+10	.152E+05	.639E+02
77.0	.119E+10	.150E+05	.613E+02
79.0	.116E+10	.148E+05	.598E+02
81.0	.117E+10	.151E+05	.602E+02
83.0	.114E+10	.151E+05	.591E+02
85.0	.112E+10	.149E+05	.580E+02
87.0	.110E+10	.146E+05	.568E+02
89.0	.107E+10	.142E+05	.552E+02
91.0	.106E+10	.141E+05	.547E+02
93.0	.101E+10	.135E+05	.523E+02
95.0	.927E+09	.123E+05	.479E+02
97.0	.829E+09	.110E+05	.428E+02
99.0	.746E+09	.982E+04	.385E+02
101.0	.645E+09	.845E+04	.333E+02
103.0	.522E+09	.679E+04	.270E+02
105.0	.416E+09	.538E+04	.215E+02
107.0	.321E+09	.414E+04	.166E+02
109.0	.238E+09	.306E+04	.123E+02
111.0	.171E+09	.219E+04	.885E+01
113.0	.122E+09	.156E+04	.633E+01
115.0	.900E+08	.115E+04	.465E+01
117.0	.678E+08	.862E+03	.350E+01
119.0	.522E+08	.663E+03	.269E+01
121.0	.409E+08	.519E+03	.211E+01
123.0	.325E+08	.414E+03	.168E+01
125.0	.263E+08	.335E+03	.136E+01
127.0	.216E+08	.275E+03	.111E+01
129.0	.179E+08	.228E+03	.924E+00
131.0	.150E+08	.191E+03	.774E+00
133.0	.126E+08	.162E+03	.655E+00
135.0	.107E+08	.138E+03	.558E+00
137.0	.920E+07	.119E+03	.480E+00
139.0	.794E+07	.103E+03	.416E+00
141.0	.688E+07	.894E+02	.363E+00
1[illegible].0	.600E+07	.783E+02	.319E+00
145.0	.525E+07	.688E+02	.282E+00
147.0	.462E+07	.608E+02	.251E+00
149.0	.408E+07	.539E+02	.225E+00
155.0	.300E+07	.403E+02	.174E+00
165.0	.174E+07	.239E+02	.114E+00
175.0	.107E+07	.149E+02	.787E-01
185.0	.682E+06	.959E+01	.558E-01

195.0	.448E+06	.633E+01	.397E-01
205.0	.301E+06	.426E+01	.279E-01
215.0	.206E+06	.290E+01	.196E-01
225.0	.143E+06	.200E+01	.134E-01
235.0	.101E+06	.139E+01	.905E-02
245.0	.715E+05	.976E+00	.626E-02
255.0	.506E+05	.687E+00	.443E-02
265.0	.362E+05	.488E+00	.309E-02
275.0	.262E+05	.350E+00	.213E-02
285.0	.190E+05	.252E+00	.148E-02
295.0	.138E+05	.182E+00	.104E-02

VIBRATIONAL TEMPERATURES(K)

ALT(KM)	KINETIC	CO(1)	CO(2)
61.0	244.3	264.3	365.3
63.0	238.8	265.6	365.3
65.0	233.3	267.0	365.3
67.0	227.8	268.5	365.3
69.0	222.3	269.9	365.3
71.0	216.9	271.1	365.3
73.0	212.3	272.0	365.3
75.0	208.4	272.7	365.3
77.0	204.5	273.5	365.3
79.0	200.6	273.7	365.3
81.0	196.7	274.1	365.3
83.0	192.7	274.4	365.3
85.0	188.8	274.6	365.3
87.0	186.9	274.7	365.3
89.0	186.9	274.7	365.3
91.0	186.9	274.7	365.3
93.0	187.4	274.7	365.3
95.0	188.5	274.6	365.3
97.0	190.5	274.5	365.3
99.0	193.4	274.4	365.3
101.0	197.3	274.3	365.3
103.0	202.4	274.1	365.3
105.0	209.1	274.0	365.3
107.0	218.1	273.9	365.3
109.0	231.6	273.8	365.3
111.0	252.0	273.7	365.3
113.0	276.0	273.6	365.3
115.0	300.0	273.6	365.3
117.0	324.0	273.5	365.3
119.0	348.0	273.5	365.3
121.0	371.8	273.5	365.3
123.0	394.9	273.5	365.3
125.0	417.1	273.6	365.3
127.0	438.5	273.6	365.3
129.0	459.2	273.6	365.3
131.0	478.8	273.7	365.4
133.0	497.9	273.8	365.4
135.0	516.3	273.8	365.4
137.0	534.0	273.9	365.5
139.0	551.1	274.0	365.6
141.0	567.5	274.1	365.8
143.0	583.3	274.2	365.9
145.0	598.6	274.3	366.2
147.0	613.2	274.4	366.4
149.0	627.3	274.5	366.7
155.0	665.3	274.9	367.9
165.0	721.9	275.4	370.5
175.0	768.8	275.8	373.2
185.0	807.7	276.0	375.6

195.0	839.5	276.1	377.4
205.0	865.7	276.1	378.5
215.0	887.9	276.0	379.1
225.0	903.2	275.8	378.7
235.0	911.6	275.5	377.6
245.0	924.6	275.3	377.1
255.0	942.2	275.2	377.2
265.0	954.1	275.0	376.6
275.0	960.4	274.8	375.5
285.0	966.6	274.6	374.6
295.0	972.9	274.4	373.7

NO RADIATIVE PROPERTIES

STATE	ENERGY(CM-1)	DEGENERACY
NO(0)	.000	1.
NO(1)	1876.077	1.
NO(2)	3724.067	1.

TRANSITION		FREQUENCY(CM-1)	ESHINE T(K)	RADIANCE
NO(1)	-NO(0)	1876.077	240.0	Y
NO(2)	-NO(0)	3724.067	230.0	Y
NO(2)	-NO(1)	1847.990	240.0	Y

EXCITED STATE NUMBER DENSITIES(MOLEC/CM3)

ALT(KM)	NO(0)	NO(1)	NO(2)
61.0	.810E+08	.968E+03	.581E+01
63.0	.650E+08	.766E+03	.466E+01
65.0	.520E+08	.606E+03	.372E+01
67.0	.415E+08	.478E+03	.297E+01
69.0	.330E+08	.376E+03	.235E+01
71.0	.260E+08	.293E+03	.185E+01
73.0	.205E+08	.227E+03	.144E+01
75.0	.160E+08	.174E+03	.111E+01
77.0	.127E+08	.136E+03	.877E+00
79.0	.105E+08	.109E+03	.715E+00
81.0	.915E+07	.921E+02	.611E+00
83.0	.845E+07	.832E+02	.558E+00
85.0	.845E+07	.812E+02	.551E+00
87.0	.960E+07	.850E+02	.595E+00
89.0	.122E+08	.935E+02	.687E+00
91.0	.160E+08	.105E+03	.804E+00
93.0	.205E+08	.120E+03	.943E+00
95.0	.265E+08	.146E+03	.116E+01
97.0	.330E+08	.181E+03	.142E+01
99.0	.380E+08	.213E+03	.165E+01
101.0	.410E+08	.243E+03	.182E+01
103.0	.430E+08	.275E+03	.197E+01
105.0	.445E+08	.316E+03	.213E+01
107.0	.445E+08	.366E+03	.223E+01
109.0	.435E+08	.454E+03	.229E+01
111.0	.425E+08	.669E+03	.236E+01
113.0	.410E+08	.110E+04	.240E+01
115.0	.395E+08	.177E+04	.248E+01
117.0	.380E+08	.271E+04	.265E+01
119.0	.365E+08	.391E+04	.307E+01
121.0	.354E+08	.535E+04	.393E+01
123.0	.342E+08	.690E+04	.540E+01
125.0	.330E+08	.842E+04	.759E+01
127.0	.318E+08	.986E+04	.106E+02
129.0	.306E+08	.111E+05	.145E+02
131.0	.293E+08	.122E+05	.190E+02
133.0	.281E+08	.131E+05	.242E+02
135.0	.268E+08	.138E+05	.299E+02
137.0	.257E+08	.143E+05	.359E+02
139.0	.245E+08	.145E+05	.420E+02
141.0	.234E+08	.146E+05	.478E+02
143.0	.222E+08	.145E+05	.533E+02
145.0	.211E+08	.143E+05	.582E+02
147.0	.200E+08	.140E+05	.628E+02
149.0	.190E+08	.136E+05	.667E+02
155.0	.160E+08	.120E+05	.740E+02
165.0	.111E+08	.832E+04	.684E+02
175.0	.728E+07	.509E+04	.515E+02
185.0	.471E+07	.299E+04	.353E+02

195.0	.301E+07	.170E+04	.225E+02
205.0	.197E+07	.976E+03	.141E+02
215.0	.135E+07	.579E+03	.895E+01
225.0	.917E+06	.336E+03	.543E+01
235.0	.625E+06	.193E+03	.318E+01
245.0	.426E+06	.113E+03	.192E+01
255.0	.295E+06	.683E+02	.122E+01
265.0	.209E+06	.418E+02	.766E+00
275.0	.148E+06	.252E+02	.467E+00
285.0	.105E+06	.153E+02	.286E+00
295.0	.742E+05	.933E+01	.175E+00

VIBRATIONAL TEMPERATURES(K)

ALT(KM)	KINETIC	NO(1)	NO(2)
61.0	244.3	238.1	325.7
63.0	238.8	237.8	325.7
65.0	233.3	237.6	325.7
67.0	227.8	237.4	325.7
69.0	222.3	237.2	325.6
71.0	216.9	236.9	325.5
73.0	212.3	236.6	325.3
75.0	208.4	236.2	325.1
77.0	204.5	235.7	324.9
79.0	200.6	235.1	324.6
81.0	196.7	234.6	324.3
83.0	192.7	234.1	324.1
85.0	188.8	233.7	323.8
87.0	186.9	232.0	322.8
89.0	186.9	229.1	320.9
91.0	186.9	226.2	318.8
93.0	187.4	224.0	317.2
95.0	188.5	222.9	316.2
97.0	190.5	222.8	315.9
99.0	193.4	223.3	316.1
101.0	197.3	224.2	316.5
103.0	202.4	225.7	317.1
105.0	209.1	227.7	317.9
107.0	218.1	230.6	318.8
109.0	231.6	235.3	319.7
111.0	252.0	244.1	320.7
113.0	276.0	256.4	321.8
115.0	300.0	269.6	323.1
117.0	324.0	282.7	325.2
119.0	348.0	295.2	328.9
121.0	371.8	306.8	334.6
123.0	394.9	317.3	342.1
125.0	417.1	326.3	350.6
127.0	438.5	334.2	359.3
129.0	459.2	340.9	367.9
131.0	478.8	346.7	376.0
133.0	497.9	352.0	383.8
135.0	516.3	356.4	390.9
137.0	534.0	360.1	397.5
139.0	551.1	363.3	403.5
141.0	567.5	365.9	409.0
143.0	583.3	368.2	414.1
145.0	598.6	370.0	418.7
147.0	613.2	371.5	422.9
149.0	627.3	372.7	426.6
155.0	665.3	375.4	436.2
165.0	721.9	374.9	446.5
175.0	768.8	371.6	451.9
185.0	807.7	366.7	454.0

195.0	839.9	360.9	453.9
205.0	865.7	354.6	452.1
215.0	887.9	348.3	449.5
225.0	903.2	341.2	445.2
235.0	911.6	333.9	439.6
245.0	924.6	327.7	435.3
255.0	942.2	322.5	432.2
265.0	954.1	317.0	428.1
275.0	960.4	311.1	423.0
285.0	966.6	305.7	418.2
295.0	972.9	300.6	413.6

LINE-OF-SIGHT GEOMETRY INFORMATION

PATH SELECTION:	OBSERVER TO SOURCE
OBSERVER ALTITUDE(KM):	70.00
OBSERVER LONGITUDE(DEG):	62.00
OBSERVER LATITUDE(DEG):	50.00
SOURCE ALTITUDE(KM):	290.00
SOURCE LONGITUDE(DEG):	62.00
SOURCE LATITUDE(DEG):	60.00

SEGMENT	LOWER ALT.(KM)	UPPER ALT.(KM)	SEGMENT LENGTH(KM)	COLUMN DENSITIES(MOLEC/CM2)				
				H2O	CO2	O3	CO	NO
1	70.00	72.00	19.29	.1221E+17	.9173E+18	.2798E+15	.2371E+16	.5017E+14
2	72.00	74.00	18.77	.8464E+16	.6683E+18	.1276E+15	.2352E+16	.3847E+14
3	74.00	76.00	18.28	.5733E+16	.4830E+18	.6672E+14	.2261E+16	.2925E+14
4	76.00	78.00	17.83	.3850E+16	.3477E+18	.4100E+14	.2117E+16	.2273E+14
5	78.00	80.00	17.41	.2533E+16	.2492E+18	.3221E+14	.2014E+16	.1837E+14
6	80.00	82.00	17.02	.1598E+16	.1777E+18	.3404E+14	.1984E+16	.1557E+14
7	82.00	84.00	16.65	.9671E+15	.1261E+18	.4996E+14	.1905E+16	.1407E+14
8	84.00	86.00	16.31	.5745E+15	.8898E+17	.6770E+14	.1831E+16	.1378E+14
9	86.00	88.00	15.99	.3348E+15	.6198E+17	.7196E+14	.1759E+16	.1535E+14
10	88.00	90.00	15.69	.1896E+15	.4261E+17	.6511E+14	.1676E+16	.1922E+14
11	90.00	92.00	15.40	.1055E+15	.2931E+17	.5083E+14	.1631E+16	.2464E+14
12	92.00	94.00	15.13	.5601E+14	.2015E+17	.3632E+14	.1533E+16	.3102E+14
13	94.00	96.00	14.88	.2928E+14	.1384E+17	.2529E+14	.1379E+16	.3942E+14
14	96.00	98.00	14.63	.1379E+14	.9492E+16	.1683E+14	.1212E+16	.4829E+14
15	98.00	100.00	14.40	.5851E+13	.6516E+16	.1008E+14	.1074E+16	.5472E+14
16	100.00	102.00	14.18	.2728E+13	.4480E+16	.6023E+13	.9148E+15	.5813E+14
17	102.00	104.00	13.97	.1572E+13	.3088E+16	.4152E+13	.7290E+15	.6006E+14
18	104.00	106.00	13.77	.9853E+12	.2136E+16	.2871E+13	.5723E+15	.6126E+14
19	106.00	108.00	13.57	.6325E+12	.1481E+16	.1992E+13	.4363E+15	.6040E+14
20	108.00	110.00	13.39	.4165E+12	.1026E+16	.1380E+13	.3191E+15	.5824E+14
21	110.00	112.00	13.21	.2941E+12	.6712E+15	.8902E+12	.2264E+15	.5615E+14
22	112.00	114.00	13.04	.2264E+12	.4113E+15	.5265E+12	.1597E+15	.5347E+14
23	114.00	116.00	12.88	.1781E+12	.2626E+15	.3255E+12	.1160E+15	.5086E+14
24	116.00	118.00	12.72	.1427E+12	.1736E+15	.2089E+12	.8629E+14	.4833E+14
25	118.00	120.00	12.57	.1161E+12	.1182E+15	.1384E+12	.6557E+14	.4587E+14
26	120.00	122.00	12.42	.9576E+11	.8260E+14	.9430E+11	.5075E+14	.4395E+14
27	122.00	124.00	12.28	.8005E+11	.5911E+14	.6589E+11	.3997E+14	.4197E+14
28	124.00	126.00	12.14	.6772E+11	.4320E+14	.4708E+11	.3196E+14	.4005E+14
29	126.00	128.00	12.01	.5789E+11	.3214E+14	.3429E+11	.2590E+14	.3816E+14
30	128.00	130.00	11.88	.4992E+11	.2429E+14	.2539E+11	.2124E+14	.3635E+14
31	130.00	132.00	11.76	.4341E+11	.1862E+14	.1909E+11	.1759E+14	.3451E+14
32	132.00	134.00	11.64	.3801E+11	.1444E+14	.1454E+11	.1470E+14	.3267E+14
33	134.00	136.00	11.53	.3348E+11	.1132E+14	.1119E+11	.1238E+14	.3093E+14
34	136.00	138.00	11.41	.2965E+11	.8964E+13	.8711E+10	.1051E+14	.2929E+14
35	138.00	140.00	11.30	.2640E+11	.7159E+13	.6841E+10	.8970E+13	.2775E+14
36	140.00	142.00	11.20	.2361E+11	.5763E+13	.5419E+10	.7705E+13	.2619E+14
37	142.00	144.00	11.10	.2120E+11	.4673E+13	.4325E+10	.6653E+13	.2464E+14
38	144.00	146.00	10.99	.1912E+11	.3814E+13	.3477E+10	.5773E+13	.2318E+14
39	146.00	148.00	10.90	.1729E+11	.3131E+13	.2813E+10	.5031E+13	.2181E+14
40	148.00	150.00	10.80	.1569E+11	.2586E+13	.2289E+10	.4403E+13	.2052E+14

41	150.00	160.00	52.68	.6120E+11	.8223E+13	.7081E+10	.1580E+14	.8429E+14
42	160.00	170.00	50.65	.4031E+11	.3516E+13	.2831E+10	.8819E+13	.5650E+14
43	170.00	180.00	48.84	.2777E+11	.1627E+13	.1232E+10	.5216E+13	.3556E+14
44	180.00	190.00	47.22	.1977E+11	.7977E+12	.5705E+09	.3218E+13	.2226E+14
45	190.00	200.00	45.76	.1443E+11	.4084E+12	.2766E+09	.2050E+13	.1379E+14
46	200.00	210.00	44.44	.1074E+11	.2164E+12	.1390E+09	.1340E+13	.8779E+13
47	210.00	220.00	43.22	.8118E+10	.1176E+12	.7185E+08	.8920E+12	.5818E+13
48	220.00	230.00	42.11	.6223E+10	.6535E+11	.3799E+08	.6042E+12	.3862E+13
49	230.00	240.00	41.08	.4837E+10	.3707E+11	.2053E+08	.4161E+12	.2567E+13
50	240.00	250.00	40.13	.3760E+10	.2114E+11	.1116E+08	.2871E+12	.1708E+13
51	250.00	260.00	39.25	.2923E+10	.1211E+11	.6104E+07	.1985E+12	.1157E+13
52	260.00	270.00	38.42	.2296E+10	.7050E+10	.3393E+07	.1390E+12	.8020E+12
53	270.00	280.00	37.65	.1823E+10	.4168E+10	.1917E+07	.9851E+11	.5566E+12
54	280.00	290.00	36.93	.1451E+10	.2478E+10	.1090E+07	.7010E+11	.3867E+12

54 LAYERS TOTAL PATH LENGTH: 1162.75

BAND RADIANCE SUMMARY

TRANSITION	FREQUENCY(CM-1)	NO. OF LINES TOTAL	RELAYERED	BAND RADIANCE (W/SR/CM2)
H2O(010) -H2O(000)	1594.750	1741	0	.35917E-07
H2O(020) -H2O(000)	3151.630	1132	0	.12333E-09
H2O(100) -H2O(000)	3657.053	1302	0	.86359E-10
H2O(001) -H2O(000)	3755.930	1546	0	.10444E-07
H2O(030) -H2O(000)	4666.793	413	0	.17380E-15
H2O(110) -H2O(000)	5234.977	188	0	.21018E-17
H2O(011) -H2O(000)	5331.269	148	0	.59619E-17
H2O(020) -H2O(010)	1556.880	686	0	.39387E-08
H2O(100) -H2O(010)	2062.303	402	0	.15772E-10
H2O(001) -H2O(010)	2161.180	365	0	.20350E-09
H2O(030) -H2O(010)	3072.043	313	0	.32815E-13
H2O(110) -H2O(010)	3640.227	365	0	.87867E-14
H2O(011) -H2O(010)	3736.519	527	0	.34855E-12
H2O(030) -H2O(020)	1515.163	121	0	.57705E-12
		-----	-----	------------
TOTAL		9249	0	.50730E-07

CO2(01101)-CO2(00001)	667.380	153	0	.22564E-05
CO2(11102)-CO2(00001)	1932.470	117	0	.83399E-10
CO2(11101)-CO2(00001)	2076.856	127	0	.36010E-09
CO2(00011)-CO2(00001)	2349.143	110	0	.18782E-07
CO2(10012)-CO2(00001)	3612.842	99	0	.11264E-08
CO2(10011)-CO2(00001)	3714.783	99	0	.67392E-09
CO2(20013)-CO2(00001)	4853.623	83	0	.23191E-10
CO2(20012)-CO2(00001)	4977.834	62	0	.81420E-10
CO2(20011)-CO2(00001)	5099.660	0	0	.00000E+00
CO2(10002)-CO2(01101)	618.029	136	0	.11357E-06
CO2(02201)-CO2(01101)	667.752	276	0	.60175E-06
CO2(10001)-CO2(01101)	720.805	136	0	.96740E-07
CO2(01111)-CO2(01101)	2336.632	278	0	.19163E-07
CO2(11102)-CO2(10002)	647.061	128	0	.69489E-07
CO2(11101)-CO2(10002)	791.447	110	0	.18706E-08
CO2(00011)-CO2(10002)	1063.734	77	0	.13659E-07
CO2(10012)-CO2(10002)	2327.433	93	0	.38259E-06
CO2(20013)-CO2(10002)	3568.214	81	0	.19476E-08
CO2(20012)-CO2(10002)	3692.425	81	0	.22102E-08
CO2(11102)-CO2(02201)	597.338	229	0	.80415E-08
CO2(03301)-CO2(02201)	668.114	247	0	.50987E-07
CO2(11101)-CO2(02201)	741.724	235	0	.86455E-08
CO2(02211)-CO2(02201)	2324.141	250	0	.57894E-07
CO2(11102)-CO2(10001)	544.285	104	0	.83720E-09
CO2(11101)-CO2(10001)	688.671	125	0	.34292E-07
CO2(00011)-CO2(10001)	960.958	75	0	.11701E-07
CO2(10011)-CO2(10001)	2326.598	91	0	.21125E-06
CO2(20012)-CO2(10001)	3589.649	79	0	.14471E-08
CO2(20011)-CO2(10001)	3711.475	81	0	.31085E-08

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TOTAL			3762	0	.39687E-05
03(010)	-03(000)	700.931	6340	0	.24768E-08
03(001)	-03(000)	1042.084	6992	0	.27897E-07
03(100)	-03(000)	1103.140	6671	0	.56487E-09
03(011)	-03(000)	1726.528	1709	0	.41286E-11
03(110)	-03(000)	1796.261	2137	0	.96663E-12
03(002)	-03(000)	2057.892	2164	0	.26180E-09
03(101)	-03(000)	2110.785	2165	0	.23016E-08
03(200)	-03(000)	2201.157	1530	0	.28077E-10
03(111)	-03(000)	2785.245	1449	0	.28625E-12
03(003)	-03(000)	3041.200	1575	0	.86237E-09
03(020)	-03(010)	698.344	4591	0	.37332E-10
03(011)	-03(010)	1025.597	1544	0	.22034E-09
03(110)	-03(010)	1095.330	901	0	.28888E-11
03(111)	-03(010)	2084.314	1469	0	.43107E-11
03(002)	-03(001)	1015.808	1534	0	.92911E-08
03(101)	-03(100)	1007.645	1185	0	.29334E-08
03(003)	-03(002)	983.308	3510	0	.10705E-07
03(004)	-03(003)	946.800	1518	0	.68536E-08
03(005)	-03(004)	922.000	1521	0	.39265E-08
03(006)	-03(005)	893.000	1533	0	.19266E-08
03(007)	-03(006)	862.000	1528	0	.77422E-09
03(008)	-03(007)	832.000	1527	0	.21647E-09
03(009)	-03(008)	802.000	1526	0	.40422E-10
			-----	-----	------------
TOTAL			56619	0	.71331E-07
CO(1)	-CO(0)	2143.272	79	0	.23022E-07
CO(2)	-CO(0)	4260.063	64	0	.11131E-10
CO(2)	-CO(1)	2116.791	45	0	.34728E-09
			-----	-----	------------
TOTAL			188	0	.23380E-07
NO(1)	-NO(0)	1876.077	833	0	.16868E-07
NO(2)	-NO(0)	3724.067	832	0	.11095E-10
NO(2)	-NO(1)	1847.990	831	0	.16650E-09
			-----	-----	------------
TOTAL			2496	0	.17046E-07

Output file for second test case.

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   SSSSSS   HH   HH    AAAAAA    RRRRRR     CCCCCC
  SS       HH   HH   AA   AA   RR   RR    CC
 SS       HH   HH   AA   AA   RR   RR    CC
 SSSSS   HHHHHHHH   AAAAAAAA   RRRRRRR    CC
   SS   HH   HH   AA   AA   RR   RR    CC
  SS   HH   HH   AA   AA   RR    RR   CC
SSSSSS   HH   HH   AA   AA   RR     RR   CCCCCC
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STRATEGIC HIGH ALTITUDE RADIANCE CODE

VERSION 1.0

**********   CO   NIGHT   WINTER   45-LATITUDE   **********

Sat Feb 4 12:57:41 1989

SELECTED MOLECULAR RADIATORS AND INPUT FILES NAMES

1 MOLECULAR RADIATORS

SPECIES	AFGL	LINK FILE	STATE FILE	BAND FILE
CO	5	COLINK.DAT	COSTAT.DAT	COBAND.DAT

ATMOSPHERIC PROFILE

ATMOSPHERE FILE NAME: SAT45WN.DAT
NUMBER OF LAYERS: 60
EXOATMOSPHERIC TEMPERATURE(K): 1500.0
DAY-NIGHT PARAMETER: NIGHT

ALT(KM)	TEMP(K)	TOTAL NUMBER DENSITY(MOLEC/CM3)									
		O2	O	CH4	CO2	H2O	NO	N2O	CO	N2	O3
60.0	250.8	.107E+16	.100E+07	.476E+14	.160E+13	.246E+11	.900E+08	.509E+11	.713E+09	.398E+16	.733E+10
62.0	246.9	.828E+15	.251E+07	.369E+14	.124E+13	.188E+11	.720E+08	.395E+11	.790E+09	.309E+16	.481E+10
64.0	242.9	.640E+15	.631E+07	.285E+14	.959E+12	.143E+11	.580E+08	.305E+11	.855E+09	.239E+16	.317E+10
66.0	238.9	.493E+15	.158E+08	.220E+14	.739E+12	.106E+11	.460E+08	.235E+11	.941E+09	.184E+16	.180E+10
68.0	234.8	.378E+15	.398E+08	.169E+14	.567E+12	.797E+10	.370E+08	.180E+11	.975E+09	.141E+16	.870E+09
70.0	230.7	.289E+15	.100E+09	.129E+14	.433E+12	.586E+10	.290E+08	.138E+11	.965E+09	.108E+16	.380E+09
72.0	226.6	.219E+15	.251E+09	.978E+13	.329E+12	.428E+10	.230E+08	.105E+11	.101E+10	.818E+15	.160E+09
74.0	222.5	.166E+15	.631E+09	.740E+13	.249E+12	.304E+10	.180E+08	.792E+10	.103E+10	.619E+15	.800E+08
76.0	218.4	.125E+15	.158E+10	.557E+13	.187E+12	.214E+10	.140E+08	.596E+10	.101E+10	.466E+15	.100E+09
78.0	214.3	.935E+14	.398E+10	.417E+13	.140E+12	.149E+10	.115E+08	.447E+10	.982E+09	.349E+15	.150E+09
80.0	210.2	.697E+14	.100E+11	.311E+13	.104E+12	.998E+09	.960E+07	.333E+10	.998E+09	.260E+15	.210E+09
82.0	206.1	.516E+14	.205E+11	.230E+13	.773E+11	.636E+09	.870E+07	.246E+10	.103E+10	.192E+15	.250E+09
84.0	201.9	.380E+14	.420E+11	.169E+13	.569E+11	.393E+09	.820E+07	.181E+10	.997E+09	.142E+15	.280E+09
86.0	199.6	.276E+14	.860E+11	.123E+13	.413E+11	.241E+09	.870E+07	.132E+10	.103E+10	.103E+15	.260E+09
88.0	199.6	.198E+14	.151E+12	.881E+12	.296E+11	.142E+09	.105E+08	.944E+09	.991E+09	.737E+14	.220E+09
90.0	199.6	.142E+14	.244E+12	.632E+12	.212E+11	.846E+08	.140E+08	.677E+09	.101E+10	.528E+14	.180E+09
92.0	201.6	.101E+14	.343E+12	.450E+12	.151E+11	.461E+08	.180E+08	.481E+09	.101E+10	.376E+14	.130E+09
94.0	207.0	.709E+13	.416E+12	.316E+12	.106E+11	.254E+08	.230E+08	.339E+09	.948E+09	.264E+14	.920E+08
96.0	212.4	.504E+13	.447E+12	.225E+12	.755E+10	.130E+08	.300E+08	.241E+09	.866E+09	.188E+14	.620E+08
98.0	217.9	.361E+13	.448E+12	.161E+12	.541E+10	.575E+07	.360E+08	.172E+09	.793E+09	.135E+14	.400E+08
100.0	223.3	.261E+13	.430E+12	.116E+12	.391E+10	.259E+07	.400E+08	.125E+09	.747E+09	.972E+13	.260E+08
102.0	229.8	.189E+13	.401E+12	.844E+11	.284E+10	.151E+07	.420E+08	.904E+08	.633E+09	.706E+13	.189E+08
104.0	240.3	.137E+13	.362E+12	.609E+11	.205E+10	.978E+06	.440E+08	.652E+08	.522E+09	.509E+13	.136E+08
106.0	250.9	.999E+12	.319E+12	.446E+11	.150E+10	.656E+06	.450E+08	.477E+08	.429E+09	.373E+13	.996E+07
108.0	261.4	.741E+12	.275E+12	.330E+11	.111E+10	.457E+06	.440E+08	.354E+08	.340E+09	.276E+13	.738E+07
110.0	272.0	.556E+12	.230E+12	.248E+11	.833E+09	.332E+06	.420E+08	.265E+08	.265E+09	.207E+13	.554E+07
112.0	282.6	.411E+12	.189E+12	.172E+11	.559E+09	.275E+06	.390E+08	.200E+08	.203E+09	.158E+13	.359E+07
114.0	295.4	.306E+12	.156E+12	.120E+11	.378E+09	.229E+06	.350E+08	.151E+08	.156E+09	.122E+13	.236E+07
116.0	308.2	.230E+12	.130E+12	.851E+10	.260E+09	.191E+06	.310E+08	.115E+08	.121E+09	.943E+12	.157E+07
118.0	321.0	.175E+12	.110E+12	.612E+10	.182E+09	.161E+06	.270E+08	.891E+07	.947E+08	.740E+12	.107E+07
120.0	333.3	.135E+12	.928E+11	.447E+10	.129E+09	.137E+06	.230E+08	.696E+07	.751E+08	.586E+12	.736E+06
122.0	371.6	.987E+11	.763E+11	.310E+10	.870E+08	.109E+06	.204E+08	.515E+07	.562E+08	.439E+12	.485E+06
124.0	409.9	.743E+11	.627E+11	.223E+10	.610E+08	.893E+05	.181E+08	.392E+07	.433E+08	.338E+12	.332E+06
126.0	446.5	.576E+11	.527E+11	.165E+10	.444E+08	.745E+05	.159E+08	.307E+07	.343E+08	.268E+12	.237E+06
128.0	481.4	.457E+11	.453E+11	.126E+10	.332E+08	.633E+05	.138E+08	.246E+07	.277E+08	.216E+12	.174E+06
130.0	516.3	.368E+11	.390E+11	.981E+09	.253E+08	.544E+05	.120E+08	.200E+07	.228E+08	.178E+12	.130E+06
132.0	547.6	.303E+11	.345E+11	.780E+09	.198E+08	.475E+05	.104E+08	.166E+07	.190E+08	.149E+12	.100E+06
134.0	578.9	.252E+11	.305E+11	.628E+09	.157E+08	.418E+05	.909E+07	.139E+07	.161E+08	.126E+12	.780E+05
136.0	608.9	.212E+11	.273E+11	.513E+09	.126E+08	.371E+05	.792E+07	.118E+07	.138E+08	.107E+12	.617E+05
138.0	637.8	.180E+11	.246E+11	.424E+09	.103E+08	.332E+05	.689E+07	.101E+07	.119E+08	.926E+11	.495E+05
140.0	666.6	.154E+11	.222E+11	.353E+09	.844E+07	.298E+05	.600E+07	.871E+06	.103E+08	.804E+11	.401E+05
142.0	693.0	.134E+11	.203E+11	.297E+09	.701E+07	.270E+05	.521E+07	.759E+06	.903E+07	.705E+11	.329E+05
144.0	719.4	.116E+11	.186E+11	.252E+09	.587E+07	.246E+05	.452E+07	.664E+06	.795E+07	.621E+11	.272E+05

146.0	744.8	.102E+11	.171E+11	.215E+09	.495E+07	.224E+05	.392E+07	.585E+06	.705E+07	.550E+11	.227E
148.0	769.2	.895E+10	.157E+11	.185E+09	.420E+07	.206E+05	.340E+07	.518E+06	.628E+07	.490E+11	.190E
150.0	793.6	.791E+10	.145E+11	.160E+09	.359E+07	.190E+05	.295E+07	.460E+06	.561E+07	.438E+11	.161E
160.0	901.6	.455E+10	.104E+11	.829E+08	.176E+07	.131E+05	.160E+07	.272E+06	.341E+07	.266E+11	.748E
170.0	995.6	.283E+10	.777E+10	.468E+08	.950E+06	.962E+04	.959E+06	.173E+06	.222E+07	.173E+11	.384E
180.0	1077.0	.185E+10	.605E+10	.282E+08	.546E+06	.732E+04	.575E+06	.116E+06	.152E+07	.118E+11	.212E
190.0	1147.8	.126E+10	.484E+10	.177E+08	.330E+06	.574E+04	.368E+06	.804E+05	.107E+07	.839E+10	.123E
200.0	1209.2	.886E+09	.395E+10	.115E+08	.207E+06	.460E+04	.235E+06	.576E+05	.784E+06	.612E+10	.743E
210.0	1257.4	.639E+09	.331E+10	.776E+07	.134E+06	.376E+04	.160E+06	.423E+05	.586E+06	.458E+10	.465E
220.0	1305.6	.468E+09	.277E+10	.530E+07	.885E+05	.310E+04	.109E+06	.315E+05	.444E+06	.346E+10	.296E
230.0	1347.8	.348E+09	.234E+10	.369E+07	.596E+05	.259E+04	.743E+05	.238E+05	.341E+06	.266E+10	.193E
240.0	1383.9	.262E+09	.201E+10	.261E+07	.408E+05	.218E+04	.506E+05	.182E+05	.265E+06	.207E+10	.128E
250.0	1420.0	.199E+09	.173E+10	.186E+07	.282E+05	.185E+04	.345E+05	.140E+05	.208E+06	.162E+10	.857E
260.0	1432.8	.154E+09	.152E+10	.136E+07	.200E+05	.160E+04	.244E+05	.111E+05	.166E+06	.130E+10	.588E
270.0	1445.6	.120E+09	.133E+10	.997E+06	.142E+05	.138E+04	.173E+05	.875E+04	.133E+06	.104E+10	.406E
280.0	1455.8	.940E+08	.117E+10	.735E+06	.102E+05	.120E+04	.123E+05	.694E+04	.107E+06	.839E+09	.282E
290.0	1463.5	.738E+08	.104E+10	.544E+06	.730E+04	.104E+04	.868E+04	.553E+04	.869E+05	.678E+09	.197E
300.0	1471.2	.581E+08	.915E+09	.404E+06	.526E+04	.910E+03	.615E+04	.442E+04	.704E+05	.550E+09	.138E

AFGL SPECIES INDEX NUMBER FOR ATMOSPHERIC SPECIES

ATMOSPHERIC SPECIES	AFGL NUMBER
1	7
2	30
3	6
4	2
5	1
6	8
7	4
8	5
9	22
10	3

CO RADIATIVE PROPERTIES

STATE	ENERGY(CM-1)	DEGENERACY
CO(0)	.000	1.
CO(1)	2143.272	1.
CO(2)	4260.063	1.

TRANSITION		FREQUENCY(CM-1)	ESHINE T(K)	RADIANCE
CO(1)	-CO(0)	2143.272	230.0	Y
CO(2)	-CO(0)	4260.063	280.0	Y
CO(2)	-CO(1)	2116.791	280.0	Y

TRANSITION		NO. OF LINES	AVERAGE STRENGTH (CM-1/MOLEC-CM-2)	DISTRIBUTION
CO(1)	-CO(0)			
		2.	.506E-18	.103E+00
		21.	.350E-18	.851E+00
		7.	.136E-18	.948E+00
		4.	.710E-19	.977E+00
		5.	.313E-19	.993E+00
		2.	.142E-19	.996E+00
		4.	.716E-20	.999E+00
		2.	.322E-20	.999E+00
		3.	.162E-20	.100E+01
		7.	.441E-21	.100E+01
CO(2)	-CO(0)			
		18.	.307E-20	.734E+00
		8.	.157E-20	.901E+00
		6.	.802E-21	.965E+00
		5.	.349E-21	.988E+00
		3.	.156E-21	.994E+00
		3.	.773E-22	.997E+00
		4	.336E-22	.999E+00
		2.	.145E-22	.100E+01
		3.	.725E-23	.100E+01
		7.	.178E-23	.100E+01
CO(2)	-CO(1)			
		1.	.101E-17	.526E-01
		18.	.766E-18	.774E+00
		10.	.326E-18	.945E+00
		4.	.144E-18	.975E+00
		3.	.768E-19	.987E+00
		5.	.386E-19	.997E+00
		4.	149E-19	.100E+01

NEMESIS OUTPUT FOR CO(1) -CO(0)

EARTHSHINE FLUX(PHOTONS/SEC/CM2/CM-1):	.130E+13
SOLAR FLUX(PHOTONS/SEC/CM2/CM-1):	.000E+00
EINSTEIN A COEFFICIENT(1/SEC):	.310E+02
SUM OF EINSTEIN A COEFFICIENTS(1/SEC):	.310E+02
TOTAL NUMBER OF PHOTONS:	10000
MAXIMUM ORDER OF SCATTERING:	200

ALT(KM)	POPULATIONS(MOLEC/CM3)			PROBABILITIES		QUENCHING	EXCITATION RATES(1/SEC)		
	LOWER STATE	UPPER STATE		RE-EMISSION	ESCAPE	RATE(1/SEC)	EARTH	SUN	ATMOSPHERE
		INITIAL	FINAL						
.610E+02	.752E+09	.141E+04	.155E+04	.684E+00	.978E+00	.143E+02	.256E-04	.000E+00	.699E-05
.630E+02	.823E+09	.122E+04	.139E+04	.744E+00	.977E+00	.107E+02	.255E-04	.000E+00	.763E-05
.650E+02	.898E+09	.109E+04	.130E+04	.797E+00	.974E+00	.790E+01	.252E-04	.000E+00	.789E-05
.670E+02	.958E+09	.982E+03	.122E+04	.842E+00	.974E+00	.582E+01	.248E-04	.000E+00	.817E-05
.690E+02	.970E+09	.878E+03	.113E+04	.879E+00	.974E+00	.426E+01	.244E-04	.000E+00	.831E-05
.710E+02	.985E+09	.817E+03	.109E+04	.909E+00	.974E+00	.310E+01	.239E-04	.000E+00	.843E-05
730E+02	.102E+10	.794E+03	.108E+04	.932E+00	.973E+00	.225E+01	.235E-04	.000E+00	.848E-05
.750E+02	.102E+10	.763E+03	.106E+04	.950E+00	.971E+00	.162E+01	.230E-04	.000E+00	.852E-05
.770E+02	.998E+09	.722E+03	.102E+04	.964E+00	.972E+00	.115E+01	.225E-04	.000E+00	.859E-05
.790E+02	.990E+09	.698E+03	.992E+03	.974E+00	.972E+00	.819E+00	.220E-04	.000E+00	.858E-05
.810E+02	.102E+10	.701E+03	.100E+04	.982E+00	.973E+00	.577E+00	.216E-04	.000E+00	.860E-05
.830E+02	.102E+10	.687E+03	.991E+03	.987E+00	.970E+00	.404E+00	.211E-04	.000E+00	.849E-05
.850E+02	.101E+10	.670E+03	.972E+03	.991E+00	.973E+00	.283E+00	.206E-04	.000E+00	.852E-05
.870E+02	.101E+10	.656E+03	.954E+03	.994E+00	.973E+00	.201E+00	.202E-04	.000E+00	.843E-05
.890E+02	.100E+10	.639E+03	.933E+03	.995E+00	.971E+00	.144E+00	.198E-04	.000E+00	.827E-05
.910E+02	.101E+10	.632E+03	.924E+03	.997E+00	.972E+00	.104E+00	.194E-04	.000E+00	.817E-05
.930E+02	.979E+09	.600E+03	.878E+03	.997E+00	.975E+00	.778E-01	.190E-04	.000E+00	.810E-05
950E+02	.907E+09	.545E+03	.798E+03	.998E+00	.976E+00	.591E-01	.186E-04	.000E+00	.798E-05
.970E+02	.829E+09	.490E+03	.716E+03	.999E+00	.978E+00	.452E-01	.183E-04	.000E+00	.789E-05
990E+02	.770E+09	.447E+03	.655E+03	.999E+00	.977E+00	.348E-01	.180E-04	.000E+00	.775E-05
.101E+03	.690E+09	.395E+03	.577E+03	.999E+00	.978E+00	.270E-01	.177E-04	.000E+00	.762E-05
103E+03	.577E+09	.326E+03	.476E+03	.999E+00	.983E+00	.215E-01	.175E-04	.000E+00	.759E-05
.105E+03	.476E+09	.267E+03	.388E+03	.999E+00	.986E+00	.175E-01	.173E-04	.000E+00	.754E-05
107E+03	.385E+09	.214E+03	.311E+03	.100E+01	.986E+00	.143E-01	.171E-04	.000E+00	.744E-05
109E+03	.303E+09	.167E+03	.242E+03	100E+01	.991E+00	.118E-01	.170E-04	.000E+00	.745E-05
.111E+03	.234E+09	.129E+03	.187E+03	.100E+01	.992E+00	.985E-02	.169E-04	.000E+00	.741E-05
113E+03	.179E+09	.988E+02	.143E+03	.100E+01	.993E+00	.833E-02	.169E-04	.000E+00	.738E-05
115E+03	.138E+09	.762E+02	.110E+03	.100E+01	.995E+00	.713E-02	.168E-04	.000E+00	.740E-05
.117E+03	.108E+09	.596E+02	.857E+02	.100E+01	.996E+00	.614E-02	.168E-04	.000E+00	.739E-05
.119E+03	.849E+08	.471E+02	.676E+02	.100E+01	.997E+00	.532E-02	.167E-04	.000E+00	.739E-05
.121E+03	.657E+08	.371E+02	.529E+02	.100E+01	.997E+00	.492E-02	.167E-04	.000E+00	.740E-05
123E+03	.498E+08	.297E+02	.417E+02	.100E+01	.998E+00	.478E-02	.167E-04	.000E+00	.741E-05
.125E+03	.388E+08	.253E+02	.346E+02	.100E+01	.998E+00	.468E-02	.167E-04	.000E+00	.742E-05
127E+03	.310E+08	.227E+02	.302E+02	.100E+01	.999E+00	.462E-02	.167E-04	.000E+00	.743E-05
129E+03	.252E+08	.214E+02	.275E+02	.100E+01	.999E+00	.461E-02	.167E-04	.000E+00	.745E-05
131E+03	.209E+08	.207E+02	.258E+02	.100E+01	.999E+00	.463E-02	.167E-04	.000E+00	.746E-05
.133E+03	.176E+08	.206E+02	.248E+02	.100E+01	.999E+00	.467E-02	.166E-04	.000E+00	.747E-05
135E+03	.149E+08	.207E+02	.244E+02	.100E+01	.999E+00	.475E-02	.166E-04	.000E+00	.748E-05
137E+03	.128E+08	.211E+02	.242E+02	.100E+01	.999E+00	.484E-02	.166E-04	.000E+00	.750E-05
139E+03	.111E+08	.216E+02	.243E+02	.100E+01	999E+00	.496E-02	.166E-04	.000E+00	.751E-05

.141E+03	.967E+07	.222E+02	.245E+02	.100E+01	.999E+00	.508E-02	.166E-04	.000E+00	.752E-05
.143E+03	849E+07	.227E+02	.248E+02	.100E+01	.100E+01	.522E-02	.166E-04	.000E+00	.753E-05
.145E+03	.750E+07	.232E+02	.251E+02	.100E+01	.100E+01	.535E-02	.166E-04	.000E+00	.752E-05
.147E+03	.666E+07	.237E+02	.253E+02	.100E+01	.100E+01	.549E-02	.166E-04	.000E+00	.753E-05
.149E+03	595E+07	.240E+02	.255E+02	.100E+01	.100E+01	.562E-02	.166E-04	.000E+00	.754E-05
.155E+03	.451E+07	.259E+02	.270E+02	.100E+01	.999E+00	.613E-02	.166E-04	.000E+00	.742E-05
.165E+03	.281E+07	.250E+02	.257E+02	.100E+01	.999E+00	.669E-02	.166E-04	.000E+00	.745E-05
.175E+03	.187E+07	.227E+02	.232E+02	.100E+01	.100E+01	.707E-02	.166E-04	.000E+00	.740E-05
185E+03	.130E+07	.197E+02	.200E+02	.100E+01	.100E+01	.728E-02	.166E-04	.000E+00	.742E-05
.195E+03	929E+06	.165E+02	.167E+02	.100E+01	.100E+01	.732E-02	.166E-04	.000E+00	.745E-05
205E+03	685E+06	.134E+02	.135E+02	.100E+01	.100E+01	.719E-02	.166E-04	.000E+00	.747E-05
215E+03	.515E+06	.107E+02	.108E+02	.100E+01	.100E+01	.696E-02	.166E-04	000E+00	.747E-05
.225E+03	.392E+06	.848E+01	.858E+01	.100E+01	.100E+01	.669E-02	.166E-04	000E+00	.749E-05
235E+03	.303E+06	.667E+01	.674E+01	.100E+01	.100E+01	.638E-02	.166E-04	.000E+00	.749E-05
.245E+03	.236E+06	.523E+01	.529E+01	.100E+01	.100E+01	.605E-02	.166E-04	.000E+00	.749E-05
.255E+03	.187E+06	.398E+01	.403E+01	.100E+01	.100E+01	.560E-02	.166E-04	.000E+00	.750E-05
.265E+03	.150E+06	.296E+01	.300E+01	.100E+01	.100E+01	.509E-02	.166E-04	.000E+00	.750E-05
.275E+03	120E+06	.220E+01	.223E+01	.100E+01	.100E+01	.461E-02	.166E-04	.000E+00	.750E-05
.285E+03	.972E+05	.162E+01	.165E+01	.100E+01	.100E+01	.415E-02	.166E-04	.000E+00	.749E-05
.295E+03	.787E+05	.120E+01	.122E+01	.100E+01	.100E+01	.374E-02	.166E-04	.000E+00	.749E-05

EXCITED STATE NUMBER DENSITIES(MOLEC/CM3)

ALT(KM)	CO(0)	CO(1)	CO(2)
61.0	.752E+09	.155E+04	.905E-09
63.0	.823E+09	.139E+04	.435E-09
65.0	.898E+09	.130E+04	.207E-09
67.0	.958E+09	.122E+04	.965E-10
69.0	.970E+09	.113E+04	.455E-10
71.0	.985E+09	.109E+04	.261E-10
73.0	.102E+10	.108E+04	.217E-10
75.0	.102E+10	.106E+04	.250E-10
77.0	.998E+09	.102E+04	.338E-10
79.0	.990E+09	.992E+03	.494E-10
81.0	.102E+10	.100E+04	.661E-10
83.0	.102E+10	.991E+03	.812E-10
85.0	.101E+10	.972E+03	.110E-09
87.0	.101E+10	.954E+03	.175E-09
89.0	.100E+10	.933E+03	.286E-09
91.0	.101E+10	.924E+03	.475E-09
93.0	.979E+09	.878E+03	.923E-09
95.0	.907E+09	.798E+03	.187E-08
97.0	.829E+09	.716E+03	.343E-08
99.0	.770E+09	.655E+03	.605E-08
101.0	.690E+09	.577E+03	.106E-07
103.0	.577E+09	.476E+03	.231E-07
105.0	.476E+09	.388E+03	.601E-07
107.0	.385E+09	.311E+03	.142E-06
109.0	.303E+09	.242E+03	.301E-06
111.0	.234E+09	.187E+03	.572E-06
113.0	.179E+09	.143E+03	.111E-05
115.0	.138E+09	.110E+03	.222E-05
117.0	.108E+09	.857E+02	.420E-05
119.0	.849E+08	.676E+02	.736E-05
121.0	.657E+08	.529E+02	.276E-04
123.0	.498E+08	.417E+02	.166E-03
125.0	.388E+08	.346E+02	.686E-03
127.0	.310E+08	.302E+02	.212E-02
129.0	.252E+08	.275E+02	.539E-02
131.0	.209E+08	.258E+02	.115E-01
133.0	.176E+08	.248E+02	.213E-01
135.0	.149E+08	.244E+02	.362E-01
137.0	.128E+08	.242E+02	.569E-01
139.0	.111E+08	.243E+02	.843E-01
141.0	.967E+07	.245E+02	.118E+00
143.0	.849E+07	.248E+02	157E+00
145.0	.750E+07	.251E+02	.203E+00
147.0	.666E+07	.253E+02	.253E+00
149.0	.595E+07	.255E+02	.307E+00
155.0	.451E+07	.270E+02	.498E+00
165.0	.281E+07	.257E+02	.775E+00
175.0	187E+07	.232E+02	.958E+00
185.0	130E+07	.200E+02	103E+01

195.0	.929E+06	.167E+02	.101E+01
205.0	.685E+06	.135E+02	.917E+00
215.0	.515E+06	.108E+02	.800E+00
225.0	.392E+06	.858E+01	.684E+00
235.0	.303E+06	.674E+01	.570E+00
245.0	.236E+06	.529E+01	.471E+00
255.0	.187E+06	.403E+01	.370E+00
265.0	.150E+06	.300E+01	.279E+00
275.0	.120E+06	.223E+01	.210E+00
285.0	.972E+05	.165E+01	.156E+00
295.0	.787E+05	.122E+01	.116E+00

NEMESIS OUTPUT FOR CO(2) -CO(0)

EARTHSHINE FLUX(PHOTONS/SEC/CM2/CM-1):	.106E+10
SOLAR FLUX(PHOTONS/SEC/CM2/CM-1):	.000E+00
EINSTEIN A COEFFICIENT(1/SEC):	.103E+01
SUM OF EINSTEIN A COEFFICIENTS(1/SEC):	.615E+02
TOTAL NUMBER OF PHOTONS:	10000
MAXIMUM ORDER OF SCATTERING:	200

ALT(KM)	POPULATIONS(MOLEC/CM3)			PROBABILITIES		QUENCHING	EXCITATION RATES(1/SEC)		
	LOWER STATE	UPPER STATE		RE-EMISSION	ESCAPE	RATE(1/SEC)	EARTH	SUN	ATMOSPHERE
		INITIAL	FINAL						
.610E+02	.752E+09	.196E-02	.196E-02	.168E-01	.100E+01	.494E-05	.160E-09	.000E+00	.332E-17
.630E+02	.823E+09	.215E-02	.215E-02	.168E-01	.100E+01	.322E-05	.160E-09	.000E+00	-.815E-17
.650E+02	.898E+09	.234E-02	.234E-02	.168E-01	.100E+01	.209E-05	.160E-09	.000E+00	.403E-17
.670E+02	.958E+09	.250E-02	.250E-02	.168E-01	.100E+01	.137E-05	.160E-09	.000E+00	-.339E-17
.690E+02	.970E+09	.253E-02	.253E-02	.168E-01	.100E+01	.950E-06	.160E-09	.000E+00	.677E-17
.710E+02	.985E+09	.257E-02	.257E-02	.168E-01	.100E+01	.797E-06	.160E-09	.000E+00	-.833E-18
.730E+02	.102E+10	.265E-02	.265E-02	.168E-01	.100E+01	.952E-06	.160E-09	.000E+00	-.376E-17
.750E+02	.102E+10	.267E-02	.267E-02	.168E-01	.100E+01	.161E-05	.160E-09	.000E+00	.293E-17
.770E+02	.998E+09	.260E-02	.260E-02	.168E-01	.100E+01	.326E-05	.160E-09	.000E+00	.570E-17
.790E+02	.990E+09	.258E-02	.258E-02	.168E-01	.100E+01	.704E-05	.160E-09	.000E+00	-.569E-17
.810E+02	.102E+10	.265E-02	.265E-02	.168E-01	.100E+01	.134E-04	.160E-09	.000E+00	-.221E-17
.830E+02	.102E+10	.265E-02	.265E-02	.168E-01	.100E+01	.240E-04	.160E-09	.000E+00	.680E-17
.850E+02	.101E+10	.264E-02	.264E-02	.168E-01	.100E+01	.442E-04	.160E-09	.000E+00	.464E-17
.870E+02	.101E+10	.263E-02	.263E-02	.168E-01	.100E+01	.787E-04	.160E-09	.000E+00	.626E-17
.890E+02	.100E+10	.262E-02	.262E-02	.168E-01	.100E+01	.131E-03	.160E-09	.000E+00	-.468E-17
.910E+02	.101E+10	.264E-02	.264E-02	.168E-01	.100E+01	.201E-03	.160E-09	.000E+00	.390E-18
.930E+02	.979E+09	.255E-02	.255E-02	.168E-01	.100E+01	.294E-03	.160E-09	.000E+00	.678E-17
.950E+02	.907E+09	.237E-02	.237E-02	.168E-01	.100E+01	.398E-03	.160E-09	.000E+00	-.259E-17
.970E+02	.829E+09	.216E-02	.216E-02	.168E-01	.100E+01	.489E-03	.160E-09	.000E+00	.558E-17
.990E+02	.770E+09	.201E-02	.201E-02	.168E-01	.100E+01	.564E-03	.160E-09	.000E+00	-.753E-17
.101E+03	.690E+09	.180E-02	.180E-02	.168E-01	.100E+01	.635E-03	.160E-09	.000E+00	-.445E-17
.103E+03	.577E+09	.150E-02	.150E-02	.168E-01	.100E+01	.738E-03	.160E-09	.000E+00	-.390E-18
.105E+03	.476E+09	.124E-02	.124E-02	.168E-01	.100E+01	.870E-03	.160E-09	.000E+00	.724E-17
.107E+03	.385E+09	.100E-02	.100E-02	.168E-01	.100E+01	.987E-03	.160E-09	.000E+00	-.477E-17
.109E+03	.303E+09	.789E-03	.789E-03	.168E-01	.100E+01	.108E-02	.160E-09	.000E+00	-.449E-17
.111E+03	.234E+09	.611E-03	.611E-03	.168E-01	.100E+01	.113E-02	.160E-09	.000E+00	-.393E-17
.113E+03	.179E+09	.469E-03	.469E-03	.168E-01	.100E+01	.119E-02	.160E-09	.000E+00	-.123E-17
.115E+03	.138E+09	.363E-03	.363E-03	.168E-01	.100E+01	.128E-02	.160E-09	.000E+00	.572E-17
.117E+03	.108E+09	.285E-03	.285E-03	.168E-01	.100E+01	.137E-02	.160E-09	.000E+00	-.427E-17
.119E+03	.849E+08	.229E-03	.229E-03	.168E-01	.100E+01	.145E-02	.160E-09	.000E+00	-.206E-17
.121E+03	.657E+08	.199E-03	.199E-03	.168E-01	.100E+01	.183E-02	.160E-09	.000E+00	.293E-17
.123E+03	.498E+08	.295E-03	.295E-03	.168E-01	.100E+01	.265E-02	.160E-09	.000E+00	.141E-16
.125E+03	.388E+08	.787E-03	.787E-03	.168E-01	.100E+01	.358E-02	.160E-09	.000E+00	-.339E-17
.127E+03	.310E+08	.220E-02	.220E-02	.168E-01	.100E+01	.460E-02	.160E-09	.000E+00	.258E-16
.129E+03	.252E+08	.546E-02	.546E-02	.168E-01	.100E+01	.570E-02	.160E-09	.000E+00	.543E-15
.131E+03	.209E+08	.115E-01	.115E-01	.168E-01	.100E+01	.680E-02	.160E-09	.000E+00	-.728E-15
.133E+03	.176E+08	.213E-01	.213E-01	.168E-01	.100E+01	.792E-02	.160E-09	.000E+00	.328E-15
.135E+03	.149E+08	.362E-01	.362E-01	.168E-01	.100E+01	.905E-02	.160E-09	.000E+00	.177E-14
.137E+03	.128E+08	.569E-01	.569E-01	.168E-01	.100E+01	.102E-01	.160E-09	.000E+00	-.700E-14
.139E+03	.111E+08	.843E-01	.843E-01	.168E-01	.100E+01	.113E-01	.160E-09	.000E+00	.112E-13

.141E+03	967E+07	.118E+00	.118E+00	.168E-01	.100E+01	.124E-01	.160E-09	.000E+00	-.223E-13
.143E+03	.849E+07	.158E+00	.158E+00	.167E-01	.100E+01	.134E-01	.160E-09	.000E+00	.530E-13
.145E+03	.750E+07	.203E+00	.203E+00	.167E-01	.100E+01	.144E-01	.160E-09	.000E+00	-.451E-13
.147E+03	.666E+07	.253E+00	.253E+00	.167E-01	.100E+01	.153E-01	.160E-09	.000E+00	.938E-14
149E+03	.595E+07	.307E+00	.307E+00	.167E-01	.100E+01	.162E-01	.160E-09	.000E+00	-.737E-13
.155E+03	.451E+07	.498E+00	.498E+00	.167E-01	.100E+01	.188E-01	.160E-09	.000E+00	-.299E-14
.165E+03	.281E+07	.775E+00	.775E+00	.167E-01	.100E+01	.217E-01	.160E-09	.000E+00	-.118E-12
.175E+03	.187E+07	.958E+00	.958E+00	.167E-01	.100E+01	.234E-01	.160E-09	.000E+00	-.869E-12
.185E+03	.130E+07	.103E+01	.103E+01	.167E-01	.100E+01	.242E-01	.160E-09	.000E+00	.550E-12
.195E+03	.929E+06	.101E+01	.101E+01	.167E-01	.100E+01	.243E-01	.160E-09	.000E+00	.300E-11
.205E+03	.685E+06	.917E+00	.917E+00	.167E-01	.100E+01	.237E-01	.160E-09	.000E+00	.973E-12
.215E+03	.515E+06	.800E+00	.800E+00	.167E-01	.100E+01	.228E-01	.160E-09	.000E+00	.355E-11
.225E+03	.392E+06	.684E+00	.684E+00	.167E-01	.100E+01	.218E-01	.160E-09	.000E+00	-.224E-11
.235E+03	.303E+06	.570E+00	.570E+00	.167E-01	.100E+01	.206E-01	.160E-09	.000E+00	.584E-11
.245E+03	.236E+06	.471E+00	.471E+00	.167E-01	.100E+01	.194E-01	.160E-09	.000E+00	.478E-12
.255E+03	.187E+06	.370E+00	.370E+00	.167E-01	.100E+01	.179E-01	.160E-09	.000E+00	-.126E-11
.265E+03	.150E+06	.279E+00	.279E+00	.167E-01	.100E+01	.162E-01	.160E-09	.000E+00	-.524E-11
.275E+03	.120E+06	.210E+00	.210E+00	.167E-01	.100E+01	.146E-01	.160E-09	.000E+00	-.339E-11
.285E+03	.972E+05	.156E+00	.156E+00	.167E-01	.100E+01	.132E-01	.160E-09	.000E+00	.140E-11
.295E+03	.787E+05	.116E+00	.116E+00	.168E-01	.100E+01	.118E-01	.160E-09	.000E+00	-.319E-12

EXCITED STATE NUMBER DENSITIES(MOLEC/CM3)

ALT(KM)	CO(0)	CO(1)	CO(2)
61.0	.752E+09	.155E+04	.196E-02
63.0	.823E+09	.139E+04	.215E-02
65.0	.898E+09	.130E+04	.234E-02
67.0	.958E+09	.122E+04	.250E-02
69.0	.970E+09	.113E+04	.253E-02
71.0	.985E+09	.109E+04	.257E-02
73.0	.102E+10	.108E+04	.265E-02
75.0	.102E+10	.106E+04	.267E-02
77.0	.998E+09	.102E+04	.260E-02
79.0	.990E+09	.992E+03	.258E-02
81.0	.102E+10	.100E+04	.265E-02
83.0	.102E+10	.991E+03	.265E-02
85.0	.101E+10	.972E+03	.264E-02
87.0	.101E+10	.954E+03	.263E-02
89.0	.100E+10	.933E+03	.262E-02
91.0	.101E+10	.924E+03	.264E-02
93.0	.979E+09	.878E+03	.255E-02
95.0	.907E+09	.798E+03	.237E-02
97.0	.829E+09	.716E+03	.216E-02
99.0	.770E+09	.655E+03	.201E-02
101.0	.690E+09	.577E+03	.180E-02
103.0	.577E+09	.476E+03	.150E-02
105.0	.476E+09	.388E+03	.124E-02
107.0	.385E+09	.311E+03	.100E-02
109.0	.303E+09	.242E+03	.789E-03
111.0	.234E+09	.187E+03	.611E-03
113.0	.179E+09	.143E+03	.469E-03
115.0	.138E+09	.110E+03	.363E-03
117.0	.108E+09	.857E+02	.285E-03
119.0	.849E+08	.676E+02	.229E-03
121.0	.657E+08	.529E+02	.199E-03
123.0	.498E+08	.417E+02	.295E-03
125.0	.388E+08	.346E+02	.787E-03
127.0	.310E+08	.302E+02	.220E-02
129.0	.252E+08	.275E+02	.546E-02
131.0	.209E+08	.258E+02	.115E-01
133.0	.176E+08	.248E+02	.213E-01
135.0	.149E+08	.244E+02	.362E-01
137.0	.128E+08	.242E+02	.569E-01
139.0	.111E+08	.243E+02	.843E-01
141.0	.967E+07	.245E+02	.118E+00
143.0	.849E+07	.248E+02	.158E+00
145.0	.750E+07	.251E+02	.203E+00
147.0	.666E+07	.253E+02	.253E+00
149.0	.595E+07	.255E+02	.307E+00
155.0	.451E+07	.270E+02	.498E+00
165.0	.281E+07	.257E+02	.775E+00
175.0	.187E+07	.232E+02	.958E+00
185.0	.130E+07	.200E+02	.103E+01

195.0	.929E+06	.167E+02	.101E+01
205.0	.685E+06	.135E+02	.917E+00
215.0	.515E+06	.108E+02	.800E+00
225.0	.392E+06	.858E+01	.684E+00
235.0	.303E+06	.674E+01	.570E+00
245.0	.236E+06	.529E+01	.471E+00
255.0	.187E+06	.403E+01	.370E+00
265.0	.150E+06	.300E+01	.279E+00
275.0	.120E+06	.223E+01	.210E+00
285.0	.972E+05	.165E+01	.156E+00
295.0	.787E+05	.122E+01	.116E+00

NEMESIS OUTPUT FOR CO(2) -CO(1)

EARTHSHINE FLUX(PHOTONS/SEC/CM2/CM-1):	.159E+14
SOLAR FLUX(PHOTONS/SEC/CM2/CM-1):	.000E+00
EINSTEIN A COEFFICIENT(1/SEC):	.605E+02
SUM OF EINSTEIN A COEFFICIENTS(1/SEC):	.615E+02
TOTAL NUMBER OF PHOTONS:	10000
MAXIMUM ORDER OF SCATTERING:	200

ALT(KM)	POPULATIONS(MOLEC/CM3)			PROBABILITIES		QUENCHING	EXCITATION RATES(1/SEC)		
	LOWER STATE	UPPER STATE		RE-EMISSION	ESCAPE	RATE(1/SEC)	EARTH	SUN	ATMOSPHERE
		INITIAL	FINAL						
.610E+02	.155E+04	.173E-01	.173E-01	.983E+00	.100E+01	.494E-05	.610E-03	.000E+00	.811E-11
.630E+02	.139E+04	.160E-01	.160E-01	.983E+00	.100E+01	.322E-05	.610E-03	.000E+00	.262E-11
.650E+02	.130E+04	.152E-01	.152E-01	.983E+00	.100E+01	.209E-05	.610E-03	.000E+00	.179E-10
.670E+02	.122E+04	.146E-01	.146E-01	.983E+00	.100E+01	.137E-05	.610E-03	.000E+00	-.133E-10
.690E+02	.113E+04	.138E-01	.138E-01	.983E+00	.100E+01	.950E-06	.610E-03	.000E+00	-.852E-11
.710E+02	.109E+04	.133E-01	.133E-01	.983E+00	.100E+01	.797E-06	.610E-03	.000E+00	.628E-11
.730E+02	.108E+04	.134E-01	.134E-01	.983E+00	.100E+01	.952E-06	.610E-03	.000E+00	-.233E-10
.750E+02	.106E+04	.132E-01	.132E-01	.983E+00	.100E+01	.161E-05	.610E-03	.000E+00	.162E-10
.770E+02	.102E+04	.127E-01	.127E-01	.983E+00	.100E+01	.326E-05	.610E-03	.000E+00	-.102E-10
.790E+02	.992E+03	.124E-01	.124E-01	.983E+00	.100E+01	.704E-05	.610E-03	.000E+00	.267E-11
.810E+02	.100E+04	.126E-01	.126E-01	.983E+00	.100E+01	.134E-04	.610E-03	.000E+00	-.781E-11
.830E+02	.991E+03	.125E-01	.125E-01	.983E+00	.100E+01	.240E-04	.610E-03	.000E+00	.575E-12
.850E+02	.972E+03	.123E-01	.123E-01	.983E+00	.100E+01	.442E-04	.610E-03	.000E+00	.288E-10
.870E+02	.954E+03	.121E-01	.121E-01	.983E+00	.100E+01	.787E-04	.610E-03	.000E+00	.540E-11
.890E+02	.933E+03	.119E-01	.119E-01	.983E+00	.100E+01	.131E-03	.610E-03	.000E+00	-.202E-11
.910E+02	.924E+03	.118E-01	.118E-01	.983E+00	.100E+01	.201E-03	.610E-03	.000E+00	.305E-10
.930E+02	.878E+03	.113E-01	.113E-01	.983E+00	.100E+01	.294E-03	.610E-03	.000E+00	.145E-10
.950E+02	.798E+03	.103E-01	.103E-01	.983E+00	.100E+01	.398E-03	.610E-03	.000E+00	-.316E-10
.970E+02	.716E+03	.927E-02	.927E-02	.983E+00	.100E+01	.489E-03	.610E-03	.000E+00	.723E-11
.990E+02	.655E+03	.850E-02	.850E-02	.983E+00	.100E+01	.564E-03	.610E-03	.000E+00	.285E-10
.101E+03	.577E+03	.753E-02	.753E-02	.983E+00	.100E+01	.635E-03	.610E-03	.000E+00	.189E-10
.103E+03	.476E+03	.623E-02	.623E-02	.983E+00	.100E+01	.738E-03	.610E-03	.000E+00	.160E-10
.105E+03	.388E+03	.509E-02	.509E-02	.983E+00	.100E+01	.870E-03	.610E-03	.000E+00	.302E-10
.107E+03	.311E+03	.408E-02	.408E-02	.983E+00	.100E+01	.987E-03	.610E-03	.000E+00	-.438E-10
.109E+03	.242E+03	.319E-02	.319E-02	.983E+00	.100E+01	.108E-02	.610E-03	.000E+00	-.527E-11
.111E+03	.187E+03	.246E-02	.246E-02	.983E+00	.100E+01	.113E-02	.610E-03	.000E+00	-.236E-10
.113E+03	.143E+03	.188E-02	.188E-02	.983E+00	.100E+01	.119E-02	.610E-03	.000E+00	.133E-10
.115E+03	.110E+03	.145E-02	.145E-02	.983E+00	.100E+01	.128E-02	.610E-03	.000E+00	-.183E-10
.117E+03	.857E+02	.114E-02	.114E-02	.983E+00	.100E+01	.137E-02	.610E-03	.000E+00	-.144E-10
.119E+03	.676E+02	.899E-03	.899E-03	.983E+00	.100E+01	.145E-02	.610E-03	.000E+00	-.156E-10
.121E+03	.529E+02	.724E-03	.724E-03	.983E+00	.100E+01	.183E-02	.610E-03	.000E+00	.107E-10
.123E+03	.417E+02	.709E-03	.709E-03	.983E+00	.100E+01	.265E-02	.610E-03	.000E+00	.225E-10
.125E+03	.346E+02	.113E-02	.113E-02	.983E+00	.100E+01	.358E-02	.610E-03	.000E+00	.810E-10
.127E+03	.302E+02	.250E-02	.250E-02	.983E+00	.100E+01	.460E-02	.610E-03	.000E+00	.173E-09
.129E+03	.275E+02	.573E-02	.573E-02	.983E+00	.100E+01	.570E-02	.610E-03	.000E+00	.324E-09
.131E+03	.258E+02	.118E-01	.118E-01	.983E+00	.100E+01	.680E-02	.610E-03	.000E+00	-.188E-09
.133E+03	.248E+02	.216E-01	.216E-01	.983E+00	.100E+01	.792E-02	.610E-03	.000E+00	.406E-09
.135E+03	.244E+02	.365E-01	.365E-01	.983E+00	.100E+01	.905E-02	.610E-03	.000E+00	-.119E-08
.137E+03	.242E+02	.571E-01	.571E-01	.983E+00	.100E+01	.102E-01	.610E-03	.000E+00	-.151E-08
.139E+03	.243E+02	.846E-01	.846E-01	.983E+00	.100E+01	.113E-01	.610E-03	.000E+00	.470E-08

.141E+03	.245E+02	.118E+00	.118E+00	.983E+00	.100E+01	.124E-01	.610E-03	.000E+00	.617E-08
.143E+03	.248E+02	.158E+00	.158E+00	.983E+00	.100E+01	.134E-01	.610E-03	.000E+00	.175E-07
.145E+03	.251E+02	.203E+00	.203E+00	.983E+00	.100E+01	.144E-01	.610E-03	.000E+00	-.131E-08
.147E+03	.253E+02	.253E+00	.253E+00	.983E+00	.100E+01	.153E-01	.610E-03	.000E+00	-.242E-07
.149E+03	.255E+02	.307E+00	.307E+00	.983E+00	.100E+01	.162E-01	.610E-03	.000E+00	-.707E-08
.155E+03	.270E+02	.498E+00	.498E+00	.983E+00	.100E+01	.188E-01	.610E-03	.000E+00	-.306E-07
.165E+03	.257E+02	.775E+00	.775E+00	.983E+00	.100E+01	.217E-01	.610E-03	.000E+00	.276E-07
.175E+03	.232E+02	.958E+00	.958E+00	.983E+00	.100E+01	.234E-01	.610E-03	.000E+00	.178E-07
.185E+03	.200E+02	.103E+01	.103E+01	.983E+00	.100E+01	.242E-01	.610E-03	.000E+00	-.847E-07
.195E+03	.167E+02	.101E+01	.101E+01	.983E+00	.100E+01	.243E-01	.610E-03	.000E+00	.157E-06
.205E+03	.135E+02	.917E+00	.917E+00	.983E+00	.100E+01	.237E-01	.610E-03	.000E+00	-.133E-06
.215E+03	.108E+02	.800E+00	.800E+00	.983E+00	.100E+01	.228E-01	.610E-03	.000E+00	-.104E-06
.225E+03	.858E+01	.684E+00	.684E+00	.983E+00	.100E+01	.218E-01	.610E-03	.000E+00	-.141E-06
.235E+03	.674E+01	.570E+00	.570E+00	.983E+00	.100E+01	.206E-01	.610E-03	.000E+00	-.244E-07
.245E+03	.529E+01	.471E+00	.471E+00	.983E+00	.100E+01	.194E-01	.610E-03	.000E+00	-.730E-07
.255E+03	.403E+01	.370E+00	.370E+00	.983E+00	.100E+01	.179E-01	.610E-03	.000E+00	-.207E-08
.265E+03	.300E+01	.279E+00	.279E+00	.983E+00	.100E+01	.162E-01	.610E-03	.000E+00	-.975E-07
.275E+03	.223E+01	.210E+00	.210E+00	.983E+00	.100E+01	.146E-01	.610E-03	.000E+00	.162E-06
.285E+03	.165E+01	.156E+00	.156E+00	.983E+00	.100E+01	.132E-01	.610E-03	.000E+00	.147E-06
.295E+03	.122E+01	.116E+00	.116E+00	.983E+00	.100E+01	.118E-01	.610E-03	.000E+00	.723E-07

EXCITED STATE NUMBER DENSITIES(MOLEC/CM3)

ALT(KM)	CO(0)	CO(1)	CO(2)
61.0	.752E+09	.155E+04	.173E-01
63.0	.823E+09	.139E+04	.160E-01
65.0	.898E+09	.130E+04	.152E-01
67.0	.958E+09	.122E+04	.146E-01
69.0	.970E+09	.113E+04	.138E-01
71.0	.985E+09	.109E+04	.133E-01
73.0	.102E+10	.108E+04	.134E-01
75.0	.102E+10	.106E+04	.132E-01
77.0	.998E+09	.102E+04	.127E-01
79.0	.990E+09	.992E+03	.124E-01
81.0	.102E+10	.100E+04	.126E-01
83.0	.102E+10	.991E+03	.125E-01
85.0	.101E+10	.972E+03	.123E-01
87.0	.101E+10	.954E+03	.121E-01
89.0	.100E+10	.933E+03	.119E-01
91.0	.101E+10	.924E+03	.118E-01
93.0	.979E+09	.878E+03	.113E-01
95.0	.907E+09	.798E+03	.103E-01
97.0	.829E+09	.716E+03	.927E-02
99.0	.770E+09	.655E+03	.850E-02
101.0	.690E+09	.577E+03	.753E-02
103.0	.577E+09	.476E+03	.623E-02
105.0	.476E+09	.388E+03	.509E-02
107.0	.385E+09	.311E+03	.408E-02
109.0	.303E+09	.242E+03	.319E-02
111.0	.234E+09	.187E+03	.246E-02
113.0	.179E+09	.143E+03	.188E-02
115.0	.138E+09	.110E+03	.145E-02
117.0	.108E+09	.857E+02	.114E-02
119.0	.849E+08	.676E+02	.899E-03
121.0	.657E+08	.529E+02	.724E-03
123.0	.498E+08	.417E+02	.709E-03
125.0	.388E+08	.346E+02	.113E-02
127.0	.310E+08	.302E+02	.250E-02
129.0	.252E+08	.275E+02	.573E-02
131.0	209E+08	.258E+02	.118E-01
133.0	.176E+08	.248E+02	.216E-01
135.0	.149E+08	.244E+02	.365E-01
137.0	.128E+08	.242E+02	.571E-01
139.0	.111E+08	.243E+02	.846E-01
141.0	.967E+07	.245E+02	.118E+00
143.0	.849E+07	.248E+02	.158E+00
145.0	.750E+07	.251E+02	.203E+00
147.0	.666E+07	.253E+02	.253E+00
149.0	.595E+07	.255E+02	.307E+00
155.0	.451E+07	.270E+02	.498E+00
165.0	.281E+07	.257E+02	.775E+00
175.0	.187E+07	.232E+02	.958E+00
185.0	.130E+07	.200E+02	.103E+01

195.0	.929E+06	.167E+02	.101E+01
205.0	.685E+06	.135E+02	.917E+00
215.0	.515E+06	.108E+02	.800E+00
225.0	.392E+06	.858E+01	.684E+00
235.0	.303E+06	.674E+01	.570E+00
245.0	.236E+06	.529E+01	.471E+00
255.0	.187E+06	.403E+01	.370E+00
265.0	.150E+06	.300E+01	.279E+00
275.0	.120E+06	.223E+01	.210E+00
285.0	.972E+05	.165E+01	.156E+00
295.0	.787E+05	.122E+01	.116E+00

VIBRATIONAL TEMPERATURES(K)

ALT(KM)	KINETIC	CO(1)	CO(2)
61.0	248.8	235.5	250.2
63.0	244.9	232.1	248.5
65.0	240.9	229.3	247.1
67.0	236.8	227.2	246.1
69.0	232.7	225.8	245.4
71.0	228.6	224.8	244.9
73.0	224.5	224.2	244.6
75.0	220.4	223.8	244.4
77.0	216.3	223.5	244.3
79.0	212.2	223.2	244.2
81.0	208.1	223.0	244.1
83.0	204.0	222.8	244.0
85.0	200.8	222.6	243.9
87.0	199.6	222.3	243.7
89.0	199.6	222.0	243.6
91.0	200.6	221.7	243.5
93.0	204.3	221.5	243.3
95.0	209.7	221.1	243.2
97.0	215.2	220.9	243.1
99.0	220.6	220.6	242.9
101.0	226.5	220.4	242.8
103.0	235.0	220.1	242.7
105.0	245.6	220.0	242.6
107.0	256.2	219.8	242.6
109.0	266.7	219.7	242.5
111.0	277.3	219.6	242.5
113.0	289.0	219.6	242.5
115.0	301.8	219.5	242.5
117.0	314.6	219.6	242.5
119.0	327.1	219.6	242.5
121.0	352.4	219.8	242.9
123.0	390.7	220.4	245.4
125.0	428.2	221.4	252.7
127.0	463.9	222.8	263.7
129.0	498.8	224.6	276.0
131.0	531.9	226.7	287.8
133.0	563.2	228.9	298.7
135.0	593.9	231.4	309.1
137.0	623.3	234.0	318.8
139.0	652.2	236.7	327.9
141.0	679.8	239.3	336.4
143.0	706.2	242.0	344.3
145.0	732.1	244.6	351.8
147.0	757.0	247.1	358.7
149.0	781.4	249.5	365.3
155.0	847.6	256.4	382.6
165.0	948.6	265.8	405.8
175.0	1036.3	273.0	423.2
185.0	1112.4	278.4	436.5

195.0	1178.5	282.3	446.4
205.0	1233.3	284.7	453.2
215.0	1281.5	286.3	458.2
225.0	1326.7	287.4	462.2
235.0	1365.9	287.8	464.9
245.0	1401.9	288.0	466.9
255.0	1426.4	287.0	466.7
265.0	1439.2	285.0	464.6
275.0	1450.7	282.9	462.2
285.0	1459.7	280.7	459.5
295.0	1467.3	278.4	456.6

LINE-OF-SIGHT GEOMETRY INFORMATION

PATH SELECTION: LIMB VIEWING
TANGENT HEIGHT(KM): 100.00

SEGMENT	LOWER ALT. (KM)	UPPER ALT. (KM)	SEGMENT LENGTH(KM)	COLUMN DENSITIES(MOLEC/CM2) CO
1	290.00	300.00	41.65	.3277E+12
2	280.00	290.00	42.72	.4153E+12
3	270.00	280.00	43.87	.5285E+12
4	260.00	270.00	45.13	.6763E+12
5	250.00	260.00	46.51	.8699E+12
6	240.00	250.00	48.03	.1136E+13
7	230.00	240.00	49.73	.1507E+13
8	220.00	230.00	51.62	.2025E+13
9	210.00	220.00	53.76	.2769E+13
10	200.00	210.00	56.20	.3850E+13
11	190.00	200.00	59.02	.5484E+13
12	180.00	190.00	62.33	.8073E+13
13	170.00	180.00	66.29	.1237E+14
14	160.00	170.00	71.14	.2001E+14
15	150.00	160.00	77.27	.3485E+14
16	148.00	150.00	16.34	.9717E+13
17	146.00	148.00	16.69	.1112E+14
18	144.00	146.00	17.05	.1279E+14
19	142.00	144.00	17.44	.1481E+14
20	140.00	142.00	17.85	.1726E+14
21	138.00	140.00	18.30	.2028E+14
22	136.00	138.00	18.78	.2406E+14
23	134.00	136.00	19.31	.2882E+14
24	132.00	134.00	19.88	.3494E+14
25	130.00	132.00	20.51	.4287E+14
26	128.00	130.00	21.20	.5351E+14
27	126.00	128.00	21.97	.6810E+14
28	124.00	126.00	22.82	.8855E+14
29	122.00	124.00	23.79	.1184E+15
30	120.00	122.00	24.89	.1635E+15
31	118.00	120.00	26.17	.2222E+15
32	116.00	118.00	27.66	.2981E+15
33	114.00	116.00	29.44	.4070E+15
34	112.00	114.00	31.62	.5671E+15
35	110.00	112.00	34.38	.8051E+15
36	108.00	110.00	38.02	.1150E+16
37	106.00	108.00	43.14	.1659E+16
38	104.00	106.00	51.16	.2433E+16
39	102.00	104.00	66.66	.3847E+16
40	100.00	102.00	160.40	.1107E+17
41	98.00	100.00	1.00	.7701E+14
42	100.00	102.00	160.40	.1107E+17
43	102.00	104.00	66.66	.3847E+16
44	104.00	106.00	51.16	.2433E+16
45	106.00	108.00	43.14	.1659E+16

46	108.00	110.00	38.02	.1150E+16
47	110.00	112.00	34.38	.8051E+15
48	112.00	114.00	31.62	.5671E+15
49	114.00	116.00	29.44	.4071E+15
50	116.00	118.00	27.66	.2981E+15
51	118.00	120.00	26.17	.2222E+15
52	120.00	122.00	24.89	.1635E+15
53	122.00	124.00	23.79	.1184E+15
54	124.00	126.00	22.82	.8855E+14
55	126.00	128.00	21.97	.6810E+14
56	128.00	130.00	21.20	.5351E+14
57	130.00	132.00	20.51	.4287E+14
58	132.00	134.00	19.88	.3494E+14
59	134.00	136.00	19.31	.2882E+14
60	136.00	138.00	18.78	.2406E+14
61	138.00	140.00	18.30	.2028E+14
62	140.00	142.00	17.85	.1726E+14
63	142.00	144.00	17.44	.1481E+14
64	144.00	146.00	17.05	.1279E+14
65	146.00	148.00	16.69	.1112E+14
66	148.00	150.00	16.34	.9717E+13
67	150.00	160.00	77.27	.3485E+14
68	160.00	170.00	71.14	.2001E+14
69	170.00	180.00	66.29	.1237E+14
70	180.00	190.00	62.33	.8073E+13
71	190.00	200.00	59.02	.5484E+13
72	200.00	210.00	56.20	.3850E+13
73	210.00	220.00	53.76	.2769E+13
74	220.00	230.00	51.62	.2025E+13
75	230.00	240.00	49.73	.1507E+13
76	240.00	250.00	48.03	.1136E+13
77	250.00	260.00	46.51	.8699E+12
78	260.00	270.00	45.13	.6763E+12
79	270.00	280.00	43.87	.5285E+12
80	280.00	290.00	42.72	.4153E+12
81	290.00	300.00	41.65	.3277E+12

81 LAYERS TOTAL PATH LENGTH: 3242.47

SPECTRAL RADIANCE (1.00 CM-1 RESOLUTION)

W(CM-1)	RADIANCE(W/SR/CM2/CM-1)									
1900.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
1910.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
1920.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
1930.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
1940.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
1950.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
1960.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.359E-12
1970.0	.000E+00	.000E+00	.000E+00	.000E+00	.430E-12	.000E+00	.000E+00	.000E+00	.000E+00	.512E-12
1980.0	.000E+00	.000E+00	.000E+00	.000E+00	.608E-12	.000E+00	.000E+00	.000E+00	.000E+00	.720E-12
1990.0	.000E+00	.000E+00	.000E+00	.000E+00	.849E-12	.000E+00	.000E+00	.000E+00	.000E+00	.999E-12
2000.0	.000E+00	.000E+00	.000E+00	.000E+00	.117E-11	.000E+00	.000E+00	.000E+00	.000E+00	.137E-11
2010.0	.000E+00	.000E+00	.000E+00	.161E-11	.000E+00	.000E+00	.000E+00	.000E+00	.188E-11	.000E+00
2020.0	.000E+00	.000E+00	.000E+00	.221E-11	.000E+00	.320E-12	.000E+00	.000E+00	.261E-11	.000E+00
2030.0	.346E-12	.000E+00	.311E-11	.000E+00	.370E-12	.000E+00	.000E+00	.362E-11	.000E+00	.393E-12
2040.0	.000E+00	.000E+00	.447E-11	.414E-12	.000E+00	.000E+00	.563E-11	.433E-12	.000E+00	.000E+00
2050.0	.000E+00	.721E-11	.449E-12	.000E+00	.000E+00	.938E-11	.461E-12	.000E+00	.000E+00	.000E+00
2060.0	.128E-10	.000E+00	.000E+00	.000E+00	.159E-10	.473E-12	.000E+00	.000E+00	.000E+00	.210E-10
2070.0	.000E+00	.000E+00	.000E+00	.266E-10	.000E+00	.000E+00	.000E+00	.452E-12	.322E-10	.000E+00
2080.0	.000E+00	.433E-12	.384E-10	.000E+00	.000E+00	.407E-12	.444E-10	.000E+00	.000E+00	.375E-12
2090.0	.000E+00	.499E-10	.000E+00	.337E-12	.000E+00	.548E-10	.000E+00	.293E-12	.000E+00	.590E-10
2100.0	.000E+00	.243E-12	.000E+00	.625E-10	.000E+00	.187E-12	.000E+00	.653E-10	.000E+00	.128E-13
2110.0	.000E+00	.000E+00	.674E-10	.652E-13	.000E+00	.000E+00	.686E-10	.000E+00	.000E+00	.000E+00
2120.0	.690E-10	.666E-13	.000E+00	.000E+00	.684E-10	.000E+00	.000E+00	.000E+00	.664E-10	.000E+00
2130.0	.000E+00	.000E+00	.623E-10	.000E+00	.000E+00	.324E-12	.543E-10	.000E+00	.000E+00	.387E-10
2140.0	.000E+00	.000E+00	.432E-12	.000E+00	.000E+00	.000E+00	.479E-12	.395E-10	.000E+00	.519E-12
2150.0	.000E+00	.570E-10	.000E+00	.551E-12	.000E+00	.664E-10	.580E-12	.000E+00	.721E-10	.000E+00
2160.0	.600E-12	.000E+00	.759E-10	.613E-12	.000E+00	.000E+00	.788E-10	.000E+00	.000E+00	.794E-10
2170.0	.621E-12	.000E+00	.000E+00	.803E-10	.000E+00	.000E+00	.797E-10	.000E+00	.000E+00	.591E-12
2180.0	.776E-10	.000E+00	.572E-12	.753E-10	.000E+00	.549E-12	.000E+00	.721E-10	.523E-12	.000E+00
2190.0	.680E-10	.495E-12	.000E+00	.629E-10	.465E-12	.000E+00	.000E+00	.569E-10	.000E+00	.000E+00
2200.0	.501E-10	.000E+00	.000E+00	.427E-10	.000E+00	.000E+00	.352E-10	.000E+00	.000E+00	.000E+00
2210.0	.282E-10	.000E+00	.000E+00	.221E-10	.000E+00	.000E+00	.175E-10	.000E+00	.000E+00	.135E-10
2220.0	.000E+00	.000E+00	.105E-10	.000E+00	.000E+00	.827E-11	.000E+00	.000E+00	.667E-11	.000E+00
2230.0	.000E+00	.56[illegible]E-11	.000E+00	.476E-11	.000E+00	.000E+00	.405E-11	.000E+00	.000E+00	.347E-11
2240.0	.000E+00	.000E+00	.299E-11	.000E+00	.259E-11	.000E+00	.000E+00	.224E-11	.000E+00	.000E+00
2250.0	.194E-11	.000E+00	.168E-11	.000E+00	.000E+00	.145E-11	.000E-00	.124E-11	.000E+00	.000E+00
2260.0	.106E-11	.000E+00	.909E-12	.000E+00	.773E-12	.000E+00	.000E+00	.655E-12	.000E+00	.000E+00
2270.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4100.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.326E-14
4110.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.374E-14	.000E+00	.000E+00	.000E+00	.000E+00
4120.0	.000E+00	.426E-14	.000E+00	.000E+00	.000E+00	.000E+00	.482E-14	.000E+00	.000E+00	.000E+00
4130.0	.000E+00	.000E+00	.544E-14	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.609E-14	.000E+00
4140.0	.000E+00	.000E+00	.000E+00	.679E-14	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.751E-14
4150.0	.000E+00	.000E+00	.000E+00	.000E+00	.826E-14	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4160.0	.903E-14	.000E+00	.000E+00	.000E+00	.000E+00	.980E-14	.000E+00	.000E+00	.000E+00	.000E+00
4170.0	.106E-13	.000E+00	.000E+00	.000E+00	.000E+00	.113E-13	.000E+00	.000E+00	.000E+00	.000E+00

4180.0	.120E-13	.000E+00	.000E+00	.000E+00	.000E+00	.126E-13	.000E+00	.000E+00	.000E+00	.000E+00
4190.0	.132E-13	.000E+00	.000E+00	.000E+00	.000E+00	.136E-13	.000E+00	.000E+00	.000E+00	.000E+00
4200.0	.140E-13	.000E+00	.000E+00	.000E+00	.000E+00	.142E-13	.000E+00	.000E+00	.000E+00	.142E-13
4210.0	.000E+00	.000E+00	.000E+00	.000E+00	.141E-13	.000E+00	.000E+00	.000E+00	.138E-13	.000E+00
4220.0	.000E+00	.000E+00	.000E+00	.133E-13	.000E+00	.000E+00	.000E+00	.125E-13	.000E+00	.000E+00
4230.0	.000E+00	.000E+00	.116E-13	.000E+00	.000E+00	.000E+00	.104E-13	.000E+00	.000E+00	.000E+00
4240.0	.910E-14	.000E+00	.000E+00	.000E+00	.756E-14	.000E+00	.000E+00	.000E+00	.586E-14	.000E+00
4250.0	.000E+00	.000E+00	.401E-14	.000E+00	.000E+00	.000E+00	.205E-14	.000E+00	.000E+00	.000E+00
4260.0	.000E+00	.000E+00	.000E+00	.000E+00	.210E-14	.000E+00	.000E+00	.000E+00	.421E-14	.000E+00
4270.0	.000E+00	.629E-14	.000E+00	.000E+00	.000E+00	.830E-14	.000E+00	.000E+00	.102E-13	.000E+00
4280.0	.000E+00	.000E+00	.120E-13	.000E+00	.000E+00	.136E-13	.000E+00	.000E+00	.151E-13	.C00E+00
4290.0	.000E+00	.000E+00	.163E-13	.000E+00	.000E+00	.173E-13	.000E+00	.000E+00	.181E-13	.000E+00
4300.0	.000E+00	.187E-13	.000E+00	.000E+00	.191E-13	.000E+00	.193E-13	.000E+00	.000E+00	.192E-13
4310.0	.000E+00	.000E+00	.190E-13	.000E+00	.000E+00	.186E-13	.000E+00	.181E-13	.000E+00	.000E+00
4320.0	.174E-13	.000E+00	.166E-13	.000E+00	.158E-13	.000E+00	.000E+00	.149E-13	.000E+00	.139E-13
4330.0	.000E+00	.129E-13	.000E+00	.119E-13	.000E+00	.109E-13	.000E+00	.997E-14	.000E+00	.904E-14
4340.0	.000E+00	.815E-14	.730E-14	.000E+00	.651E-14	.578E-14	.000E+00	.510E-14	.000E+00	.000E+00
4350.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4360.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4370.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4380.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4390.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4400.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4410.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4420.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4430.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4440.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4450.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4460.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4470.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4480.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4490.0	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
4500.0	.000E+00									

BAND RADIANCE SUMMARY

TRANSITION		FREQUENCY(CM-1)	NO. OF LINES		BAND RADIANCE
			TOTAL	RELAYERED	(W/SR/CM2)
CO(1)	-CO(0)	2143.272	79	50	.23346E-08
CO(2)	-CO(0)	4260.063	64	64	.71067E-12
CO(2)	-CO(1)	2116.791	45	45	.18670E-10
			-----	-----	------------
TOTAL			188	159	.23539E-08

Output file for third test case. This calculation re-uses population file generated by second test case.

```
    SSSSSS   HH   HH    AAAAAA    RRRRRR     CCCCCC
   SS       HH   HH   AA    AA   RR    RR   CC
  SS       HH   HH   AA    AA   RR    RR   CC
  SSSSS   HHHHHHHH   AAAAAAAA   RRRRRRR   CC
     SS   HH   HH   AA    AA   RR   RR    CC
    SS   HH   HH   AA    AA   RR    RR   CC
SSSSSS   HH   HH   AA    AA   RR    RR   CCCCCC
```

STRATEGIC HIGH ALTITUDE RADIANCE CODE

VERSION 1.0

********** CO NIGHT WINTER 45-LATITUDE SECOND RUN WITH NEW LOS **********

Sat Feb 4 14:30:15 1989

INPUTS USED TO GENERATE NUMBER DENSITIES

DATE GENERATED:	Sat Feb 4 12:57:41 1989
POPULATION FILE NAME:	CO45WIN.DAT
ATMOSPHERE USED:	SAT45WN.DAT
NUMBER OF LAYERS:	60
EXOATMOSPHERIC TEMPERATURE(K):	1500.0
DAY-NIGHT PARAMETER:	NIGHT
NEMESIS PARAMETERS:	
TOTAL NUMBER OF PHOTONS:	10000
MAXIMUM ORDER OF SCATTERING:	200
SUNSHINE PARAMETER:	0
EARTHSHINE PARAMETER:	1
MOLECULES IN POPULATION FILE:	
	CO

TRANSITION		FREQUENCY(CM-1)	RADIANCE
CO(1)	-CO(0)	2143.272	Y
CO(2)	-CO(0)	4260.063	Y
CO(2)	-CO(1)	2116.791	Y

LINE-OF-SIGHT GEOMETRY INFORMATION

PATH SELECTION: LIMB VIEWING
TANGENT HEIGHT(KM): 150.00

SEGMENT	LOWER ALT. (KM)	UPPER ALT. (KM)	SEGMENT LENGTH(KM)	COLUMN DENSITIES(MOLEC/CM2) CO
1	290.00	300.00	48.21	.3793E+12
2	280.00	290.00	49.91	.4852E+12
3	270.00	280.00	51.81	.6242E+12
4	260.00	270.00	53.96	.8086E+12
5	250.00	260.00	56.41	.1055E+13
6	240.00	250.00	59.24	.1401E+13
7	230.00	240.00	62.57	.1896E+13
8	220.00	230.00	66.54	.2611E+13
9	210.00	220.00	71.41	.3678E+13
10	200.00	210.00	77.56	.5313E+13
11	190.00	200.00	85.69	.7963E+13
12	180.00	190.00	97.15	.1258E+14
13	170.00	180.00	115.11	.2148E+14
14	160.00	170.00	149.84	.4214E+14
15	150.00	160.00	722.55	.3259E+15
16	160.00	170.00	149.84	.4214E+14
17	170.00	180.00	115.11	.2148E+14
18	180.00	190.00	97.15	.1258E+14
19	190.00	200.00	85.69	.7963E+13
20	200.00	210.00	77.56	.5313E+13
21	210.00	220.00	71.41	.3678E+13
22	220.00	230.00	66.54	.2610E+13
23	230.00	240.00	62.57	.1896E+13
24	240.00	250.00	59.24	.1401E+13
25	250.00	260.00	56.41	.1055E+13
26	260.00	270.00	53.96	.8086E+12
27	270.00	280.00	51.81	.6242E+12
28	280.00	290.00	49.91	.4852E+12
29	290.00	300.00	48.21	.3793E+12

29 LAYERS TOTAL PATH LENGTH: 2813.40

BAND RADIANCE SUMMARY

TRANSITION		FREQUENCY(CM-1)	NO. OF LINES		BAND RADIANCE
			TOTAL	RELAYERED	(W/SR/CM2)
CO(1)	-CO(0)	2143.272	79	79	.53604E-09
CO(2)	-CO(0)	4260.063	64	64	.11637E-11
CO(2)	-CO(1)	2116.791	45	45	.29587E-10
			-----	-----	------------
TOTAL			188	188	.56679E-09

END
FILMED
6-89
DTIC